OPERATOR'S MANUAL

&

INSTALLATION GUIDE

WESTERBEKE

7.6 KW BTD - 60 Hertz
5.7 KW BTD - 50 Hertz

MARINE DIESEL

GENERATOR SET

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Edition One

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WESTERBEKE

WESTERBEKE CORPORATION • MYLES STANDISH INDUSTRIAL PARK
150 JOHN HANCOCK ROAD, TAUNTON, MA 02780-7319 U.S.A.

CALIFORNIA

Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

SAFETY PRECAUTIONS

The following symbols appear in this manual to call attention to and emphasize conditions potentially dangerous to the operator.

WARNING

The above symbol is used in the manual to warn of possible serious personal injury or loss of life.

CAUTION

The above symbol is used in the manual to caution personnel of possible damage to equipment.

Read the manual carefully and thoroughly before attempting to operate the equipment. Know when dangerous conditions can exist and take necessary precautions to protect personnel and equipment.

Fuels, exhaust gases, batteries, electrical equipment, moving and hot parts are potential hazards that could result in serious personal injury or death. Follow recommended procedures carefully.

- **Prevent Electric Shock**

  Shut off electric power before accessing electrical equipment.

  Use insulated mats whenever working on electrical equipment.

  Make sure your clothing is dry, not damp (particularly shoes), and keep your skin surfaces dry when handling electrical equipment.

  Remove wristwatch and jewelry when working on electrical equipment.

  Do not connect utility shore power to vessel's AC circuits, except through a ship-to-shore double throw transfer switch. Damage to vessel's AC generator may result if this is not done.

  Be extremely careful when working on electrical components. High voltage can cause injury or death.

- **Exhaust Gases Are Toxic**

  Ensure that exhaust system is adequate to expel gases discharged from the engine. Check exhaust system regularly for leaks and make sure the exhaust manifolds are securely attached and no warping exists.

  Be sure the unit and its surroundings are well ventilated.

- **Use Extreme Care When Handling Engine Fuel (A constant danger of explosion or fire exists)**

  Do not fill fuel tank(s) while the engine is running.

  Do not smoke or use an open flame near the engine or the fuel tank.

- **Do Not Alter or Modify the Fuel System**

  Be sure all fuel supplies have a positive shut-off valve.

  Be certain fuel line fittings are adequately tightened and free of leaks.

  Make sure a fire extinguisher is installed nearby and is properly maintained. Be familiar with its proper use. Extinguishers rated ABC by the NFPA are appropriate for all applications encountered in this environment.

- **Use Extreme Care When Servicing Batteries**

  Wear rubber gloves, a rubber apron, and eye protection when servicing batteries.

  Lead acid batteries emit hydrogen, a highly-explosive gas, which can be ignited by electrical arcing or by a lighted cigarette, cigar, or pipe. Do not smoke or allow an open flame near the battery being serviced. Shut off all electrical equipment in the vicinity to prevent electrical arcing during servicing.

- **Avoid Moving Parts**

  Do not service the unit while it is running. If a situation arises in which it is absolutely necessary to make operating adjustments, use extreme care to avoid moving parts and hot exhaust system components.

  Do not wear loose clothing or jewelry when servicing equipment; avoid wearing loose jackets shirts or sleeves, rings, necklaces, or bracelets that might be caught in moving parts.

  Make sure all attaching hardware is properly tightened. Keep protective shields and guards in their respective place at all times.

  Do not check fluid levels or the drive belt's tension while the unit is operating.

  Do not work on the equipment when mentally or physically incapacitated by fatigue.

IMPORTANT

PRODUCT SOFTWARE DISCLAIMER

Product software of all kinds, such as brochures, drawings, technical data, operator's and workshop manuals, parts lists and parts price lists, and other information, instructions and specifications provided from sources other than Westerbeke, is not within Westerbeke's control and, accordingly, is provided to Westerbeke customers only as a courtesy and service. WESTERBEKE CANNOT BE RESPONSIBLE FOR THE CONTENT OF SUCH SOFTWARE, MAKES NO WARRANTIES OR REPRESENTATIONS WITH RESPECT THERETO, INCLUDING ACCURACY, TIMELINESS OR COMPLETENESS THEREOF, AND WILL IN NO EVENT BE LIABLE FOR ANY TYPE OF DAMAGES OR INJURY INCURRED IN CONNECTION WITH, OR ARISING OUT OF, THE FURNISHING OR USE OF SUCH SOFTWARE.

For example, components and subassemblies incorporated in Westerbeke's products and supplied by others (such as engine blocks, fuel systems and components, transmissions, electrical components, pumps and other products) are generally supported by their manufacturers with their own software, and Westerbeke must depend on such software for the design of Westerbeke's own product software. Such software may be outdated and no longer accurate. Routine changes made by Westerbeke's suppliers, of which Westerbeke rarely has notice in advance, are frequently not reflected in the supplier's software until after such changes take place.

Westerbeke customers should also keep in mind the time span between printings of Westerbeke product software, and the unavoidable existence of earlier, non-current Westerbeke software editions in the field. Additionally, most Westerbeke products include customer-requested special features that frequently do not include complete documentation.

In summation, product software provided with Westerbeke products, whether from Westerbeke or other suppliers, must not and cannot be relied upon exclusively as the definitive authority on the respective product. It not only makes good sense but is imperative that appropriate representatives of Westerbeke or the supplier in question be consulted to determine the accuracy and currentness of the product software being consulted by the customer.

FOREWORD

Thank you for selecting a Westerbeke marine product for your use. We at Westerbeke are pleased to have you as a customer.

Read this manual carefully and observe all safety precautions included throughout. Operating procedures, periodic preventive maintenance procedures, installation checks, system descriptions and minor adjustment procedures are included herein so you can operate your equipment safely and properly, maintain the equipment at a high level of efficiency, and expect dependable performance and long service life in return.

Should your unit require special attention, contact your Westerbeke dealer for assistance. The Westerbeke Service Organization is trained to provide the support necessary to ensure long-term dependable performance.

WESTERBEKE
Engines & Generators

Declaration of Conformity

Application of Council Directive(s)	**EMC 89/336/EEC 92/31/EEC & 93/68/EEC**
Standard(s) to Which Conformity is declared	**CISP 12 (1990-01) EN50082-1 (1992) IEC 801 - 2 (1991), +/- 8kv AD IEC 801 - 3 (1984), 3 V/M**
Manufacturers Name	**Westerbeke Corporation**
Manufacturers Address	**41 Ledin Drive Avon Industrial Park Avon, Ma. 02322, USA**
Type of Equipment	**Marine Diesel Generator**
Product Name	**Westerbeke Marine Diesel Generator**
Model(s)	**4.0/5.0BCD, 5.7/7.6BTD 6.0/8.0BTD, 7.5/10.0BTD 8.3/11.0BTD, 9.4/12.5BTDA 12.0/15.0BTDB, 16.0/20.0BEDA 20.0/25.0BED, 25.0/32.0BEDA**
Product Options	**All**

Supplementary Information

1.) The equipment listed is only for use in Marine Applications aboard boats.
2.) The equipment listed must be located below decks on the vessel and permanently installed in its location.
3.) The equipment listed must be wired to the grounding system of the vessel.

I the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s) and Standard(s).

Place Avon, Massachusetts, U.S.A.

Carleton F. Bryant
(Signature)

Date January 1, 1996

Carleton F. Bryant
(Full Name)

Chief Operating Officer
(Title)

042021

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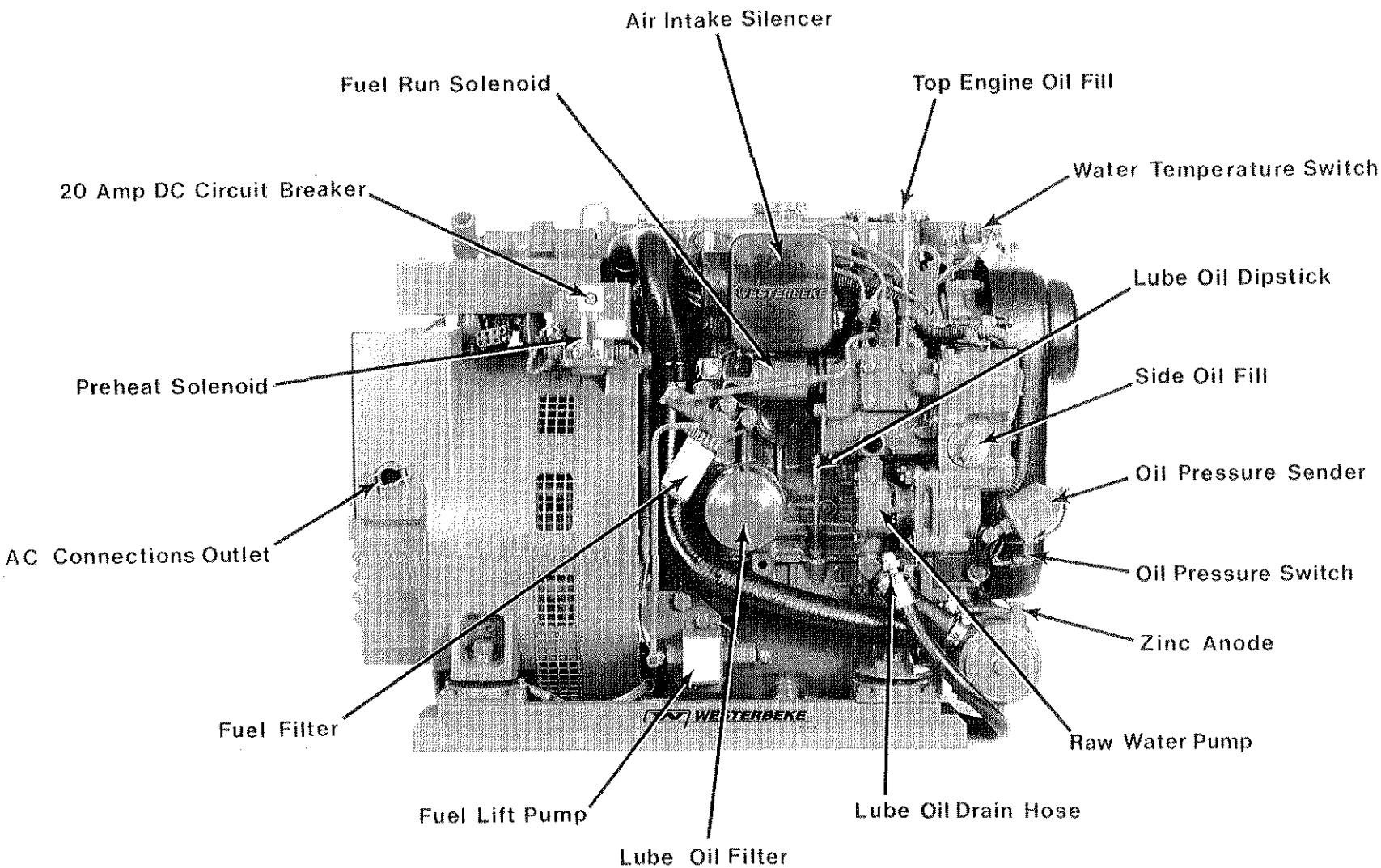
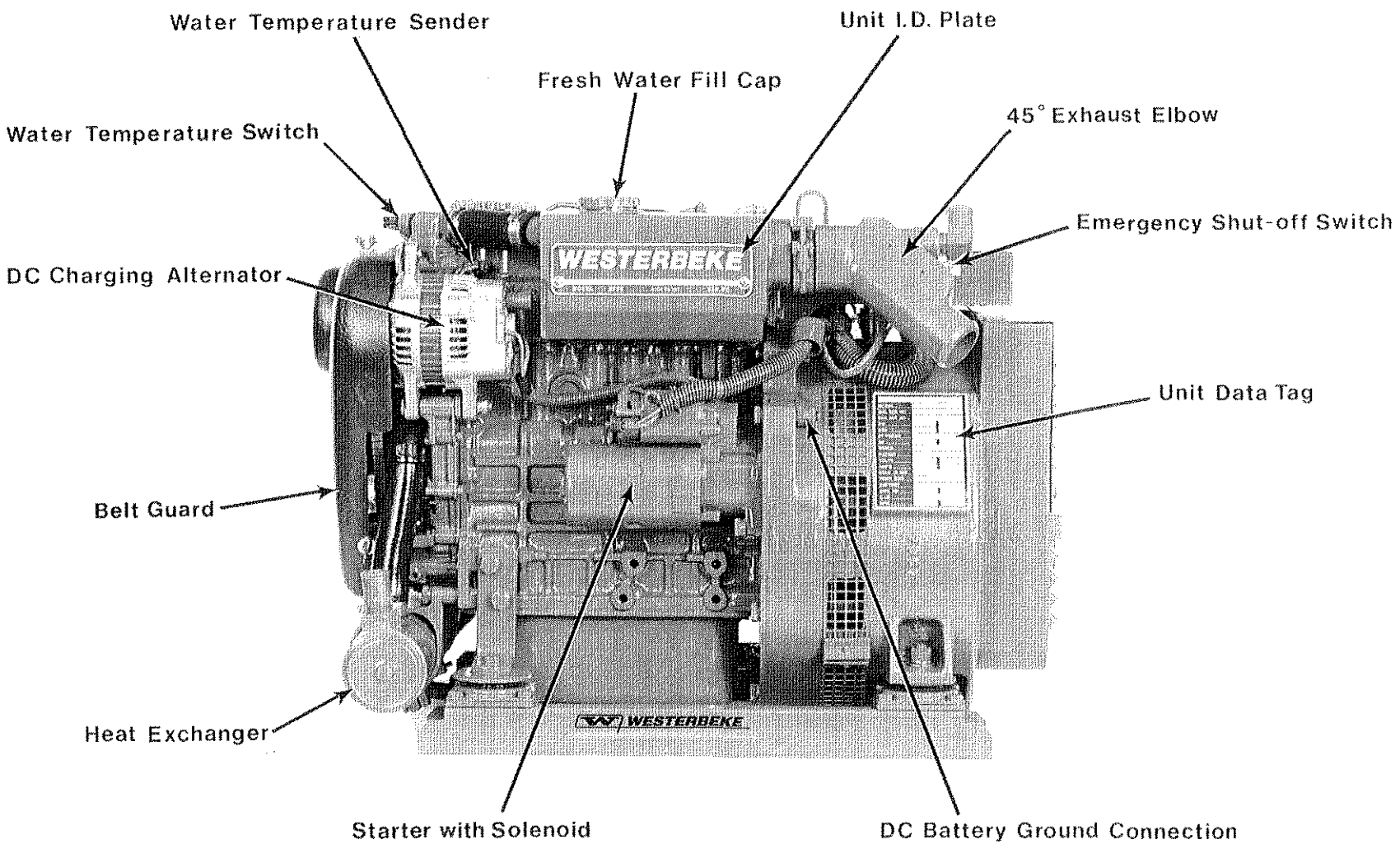


7.6 KW BTD

RIGHT SIDE



7.6 KW BTD

LEFT SIDE

GENERAL

Introduction

This manual contains the equipment operating procedures as well as additional information needed to help the operator keep the marine equipment in proper working order. Study and follow the instructions carefully. A planned maintenance program is included in this manual; adhering to the program will result in better equipment performance and longer equipment life. Proper diagnosis of a problem is the most important step to satisfactory repair; therefore, a troubleshooting table is included.

Understanding the Diesel Engine-Driven Generator

The diesel engine closely resembles the gasoline engine since the mechanism is essentially the same. The cylinders are arranged above a closed crankcase; the crankshaft is of the same general type as that of a gasoline engine; and the diesel engine has the same type of valves, camshaft, pistons, connecting rods, and lubricating system.

Therefore, to a great extent, a diesel engine requires the same preventive maintenance as a gasoline engine. The most important factors are proper ventilation and proper maintenance of the fuel, lubricating and cooling systems. Replacement of fuel and lubricating filter elements at the time periods specified is a must, and frequent checking for contamination (that is, water, sediment, or algae) in the fuel system is also essential. Another important factor is the use of the same brand of high detergent diesel lubricating oil designed specifically for diesel engines. Be careful not to put gasoline in the diesel fuel tank(s). Gasoline does not have the same lubricating qualities as diesel fuel; consequently, gasoline in the fuel lines will damage components in the fuel injection pump and fuel injectors.

The diesel engine does differ from the gasoline engine, however, in its handling and firing of fuel. The carburetor and ignition systems are done away with and in their place are two components - the fuel injection pump and the fuel injectors.

Ordering Parts

Whenever replacement parts are needed, always provide the generator model number designation (i.e. 7.6 KW BTD), engine serial number, and generator serial number as they appear on the data plates located on the exhaust manifold and on the generator end. You *must* provide us with its information so we may properly identify your generator set. In addition, include a complete part description and part number for each part needed (see the separately furnished Parts List). Also, be sure to insist upon Westerbeke factory packaged parts because "will fit" or generic parts are frequently not made to the same specifications as original equipment.

Note that component locations in the manual are referenced from the front of the engine which is the pulley/drive belt end. (The flywheel/generator end is the rear end.) Left and right sides are determined by the engine; imagine straddling the engine and facing in the same direction as the front of the engine: the left side is at your left, the right side at your right.

Westerbeke generator sets are thoroughly checked and given a final run under various load conditions before leaving the factory. Test running the generator ensures dependable operation, long service life, and a satisfied owner.

Care at the factory during assembly and thorough testing have resulted in a Westerbeke diesel engine-driven generator capable of many thousands of hours of dependable service. However, what the manufacturer cannot control is the manner or location the generator is installed in the vessel or the manner in which the unit is operated and serviced in the field. That part is up to the buyer/owner-operator.

7.6 BTD MARINE DIESEL GENERATOR SET GENERAL SPECIFICATIONS

Engine Type	Diesel, four-cycle, three cylinder, fresh water-cooled. Vertical, in-line, overhead valve mechanism. (12.5 hp at 1800 rpm, maximum).
Combustion Chamber	Swirl type.
Bore & Stroke	2.99 × 2.76 inches (75.9 × 70 mm)
Piston Displacement	58.09 cubic inches (0.952 liters)
Firing Order	1 - 3 - 2
Direction of Rotation	Clockwise, when viewed from the front
Maximum Torque (at 1800 rpm)	42 lb-ft (5.8 kg-m)
Compression Ratio	23:1
Compression Pressure	398 psi (28 kg/cm^2) at 280 rpm
Valve Timing	Intake Opens 19° BTDC Intake Closes 51° ABDC Exhaust Opens 51° BBDC Exhaust Closes 19° ATDC
Valve Seat Angle	Intake 45° Exhaust 45°
Valve Clearance (engine cold)	Intake 0.0098 inches (0.25 mm) Exhaust 0.0098 inches (0.25 mm)
Engine Speed	1800 rpm 60 hertz 1500 rpm 50 hertz
Dimensions	Length: 27.8 inches (706.1 mm) Width: 16 inches (406.4 mm) Height: 19.9 inches (505.46 mm)
Weight	340 lbs (154.22 kgs)
Fuel Consumption	0.53 U.S. gph (2 lph) at full rated output (approximately)
Inclination	Not to exceed 25°

7.6 KW BTD SYSTEM SPECIFICATIONS

FUEL SYSTEM

General	Open flow - totally self-bleeding
Fuel	No. 2 Diesel (cetane #45 or better)
Injector Pump	In-line plunger type (Bosch type)
Injectors	Throttle type
Lift Pump	12-volt DC; electric
Air cleaner	Plastic Intake Silencer
Air Flow (engine combustion)	30.2 cfm (0.85 cmm)

COOLING SYSTEM

General	Fresh water-cooled block, thermostatically-controlled with heat exchanger.
Operating Temperature	170 - 190° F (77 - 88° C)
Fresh Water Pump	Centrifugal type, metal impeller, belt-driven
Raw Water Pump	Positive displacement, rubber impeller, mechanically-driven
Raw Water Flow, at 1800 rpm (measured before discharging into exhaust elbow)	6.5 - 7.0 U.S. gpm (24.6 - 26.5 lpm)
System Capacity (fresh water)	4.0 qts (3.79 liters)

LUBRICATION SYSTEMS

General	Pressure type by Trochoid pump, gear-driven, with external pressure relief valve.
Oil Filter	Full flow, paper element, spin-on type
Sump Capacity (including filter)	3.7 U.S. qts (3.5 liters)
Operating Oil Pressure (engine hot)	35 - 55 psi (2.5 3.8 kg/cm^2)
Oil Grade	API specification of CC or CD

7.6 KW BTD SYSTEM SPECIFICATIONS (continued)

ELECTRICAL SYSTEM

Starting Battery	12-volt, (-) negative ground
Battery Capacity	350-400 Cold Cranking Amps
Starter	12-volt, 1.2 KW, Reduction type, solenoid mounted.
DC No-Load Current	90 Amp (max) at 11.5 volts
DC Cranking Current	175 - 200 Amps (engine cold)
DC Alternator	12 Volt, DC - 40 amps

AC GENERATOR

General - Single Phase	Brushless, four-pole, revolving field, transformer regulation. Prelubricated, single bearing design. Reconnectable 120 volts or 120/240 volts, single phase.
Voltage - Single Phase	120 or 120/240 volts - 60 Hertz; 220 volts - 50 Hertz. Voltage regulation: ± 5 % no load to full load. Frequency regulation:± 3 Hertz no load to full load.

Rating (Volts AC)

60 Hertz 1800 RPM 7.6 KW	120 volts 120/240 volts	63.3 Amps 63.3/31.6 Amps
50 Hertz 1500 RPM	220 volts	26 Amps
AC Circuit Breaker	To be rated at 120% of the generator's rated amperage and voltage output	
Generator Electrical End Cooling Air Requirements (60 Hertz at 1800 RPM)	175 - 200 cfm (4.95 - 5.66 cmm)	

NOTE: Increase air supply 15% for 50 hertz operation (1500 rpm)

Engine Block	100 cfm or more to remove heat produced by the engine block during operation

TUNE-UP SPECIFICATIONS

Injector Pressure	1988 psi ± 142 psi (140 kg/cm^2 ± 10 kg/cm^2)
Engine Timing (Spill Timing)	16° ± 1° BTDC Static

EMISSION CONTROL SYSTEMS

Smoke Puff Limiter

INSTALLATION CHECKS

General

Because the crafts in which Westerbeke engines and generators are installed vary in design, installation procedures will vary according to your craft's specific design. It is not the intent of this section to advise boatyards or installers on procedures already well-developed and well-understood. However, it is important that the owner/operator realize there are details of the installation which require periodic checks to ensure the best operating conditions for the equipment and safe operating conditions for the personnel on board. Proper location and installation of the generator set in the vessel are of prime importance.

Factors in the installation that *must* be considered are ventilation, so as to cool the generator and to provide air for engine combustion; exhaust system, to properly discharge raw cooling water, to quiet the exhaust and to expel the exhaust gas; cooling water supply; the electrical connections, both AC and DC, and a fuel system that will provide an unrestricted fuel supply and properly filtered fuel to the fuel pump on the engine.

CAUTION

For safety reasons, the generator's engine is not filled with lubricating oil for shipment. Before leaving the factory, however, each generator set is thoroughly tested with oil in its engine. This testing, among other things, provides all internal parts with a coating of oil. This oil acts as a preservative, providing reliable protection against corrosion for at least one year if the generator is properly stored.

Inspection of Equipment

The generator is shipped from the factory securely mounted and properly crated. Accessory equipment is shipped in a separate small box, usually packed within the generator's crate.

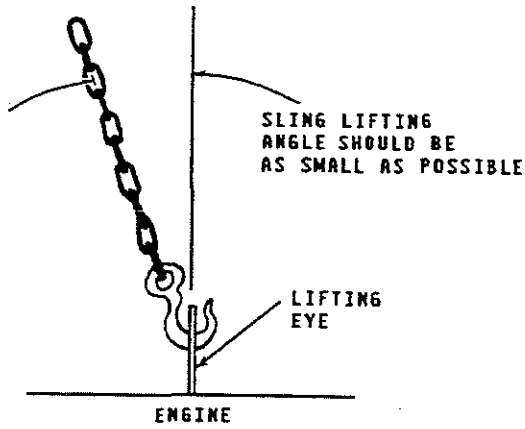
Before accepting shipment of the generator set from the transportation company, the crate should be opened and the contents inspected for concealed damage. If either visible or concealed damage is noted, you should require the delivery agent sign "Received in damaged condition" on the proper delivery receipt. Also, check the contents of the shipment against the packing list and make sure that the proper notation is made if any discrepancies exist. These noted discrepancies are your protection against loss or damage. Claims concerning loss or damage *must* be made to the *carrier*, **not** to Westerbeke Corporation.

Rigging and Lifting

The generator is fitted with lifting eyes. Rope or chain slings capable of supporting the generator's weight should be attached to the eyes and the generator lifted by means of tackle attached to these slings. Th lifting eyes have been designed to carry the full weight of the generator; therefore, auxiliary slings are not required or desired.

CAUTION

Slings must not be so short as to place significant stress on the generator's lifting eyes. Strain placed on the generator's lifting eyes by the lifting sling must not be in excess of 10° from the vertical pain.

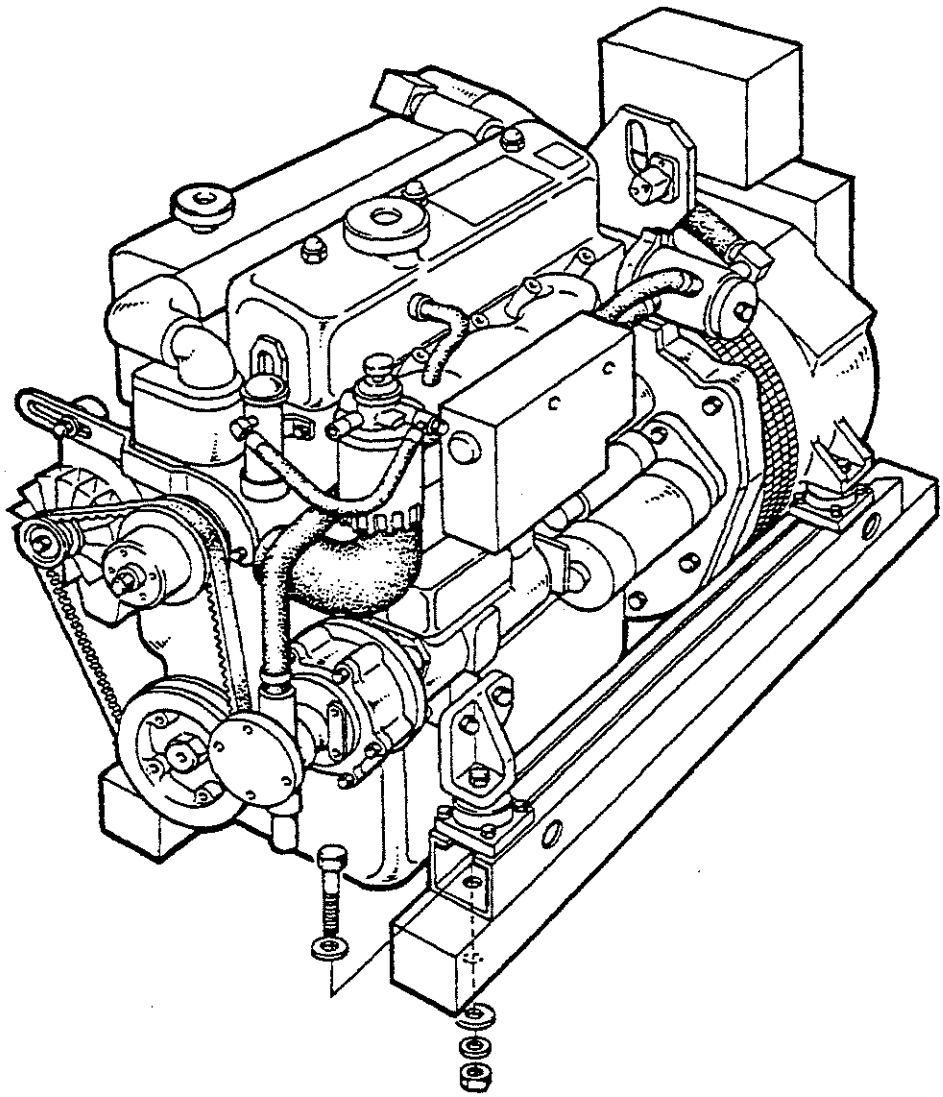


The general rule in moving generators is to see that all equipment used is amply strong and firmly fixed in place. Move the engine a little at a time and see that it is firmly supported. Eliminate the possibility of accidents by avoiding haste. Do not lift the generator by its crankshaft position. Certain situations exist by which the engine must be lowered endwise through a small hatchway which cannot be made larger. Under these conditions, if the opening of the hatchway is extremely small, it is possible to reduce, to some extent, the outside dimensions of the generator by removing external components such as the cooling system's accessory equipment should be removed by a competent mechanic and special care should be taken to avoid damage to any exposed parts. In addition, be careful not to allow dirt from entering any opening created by the removal of equipment. Removed parts should be returned to their respective position once the generator is in its installation area. Replace gaskets as needed for the parts that were removed.

In case it becomes necessary to hoist the generator front-end upwards or generator-end upwards, the attachment of lifting slings must be done *carefully* to avoid the possibility of damaging the parts on which the weight of the slings may bear. Special rigging work is best done by someone experienced and competent in handling heavy machinery.

Generator Mounting - Location

The complete generator unit is mounted on lightweight rails by means of four flexible isolator mounts that help prevent the transfer of vibration from the generator to the rails. Each generator mounting rail has several 1/2 inch bolt holes so bolts can be employed to properly secure the generator to its mounting platform.



The mounting location *must* be dry, above low-lying vapor areas, and in an area where bilge water and water from above cannot splash or drip on the generator or drive engine. The drive engine and generator *must* be accessible for minor servicing and repairs. Access for major repairs should be given consideration as well. The generator set *must* be properly ventilated to provide fresh cooling air for the generator end, for engine combustion needs, and to remove heat produced by the engine while operating. The generator set needs fresh cool air in whatever location in the vessel it is installed. Hot generator discharge air *must* be removed from the generator area. The platform on which the generator and its mounting rails are located *must* be strong enough to support the generator during all angles of vessel operation.

Exhaust System

WARNING

Carbon monoxide gas is deadly! Carbon monoxide is a dangerous gas that can cause unconsciousness and is potentially lethal. Some of the symptoms or signs of carbon monoxide inhalation or poisoning are listed below.

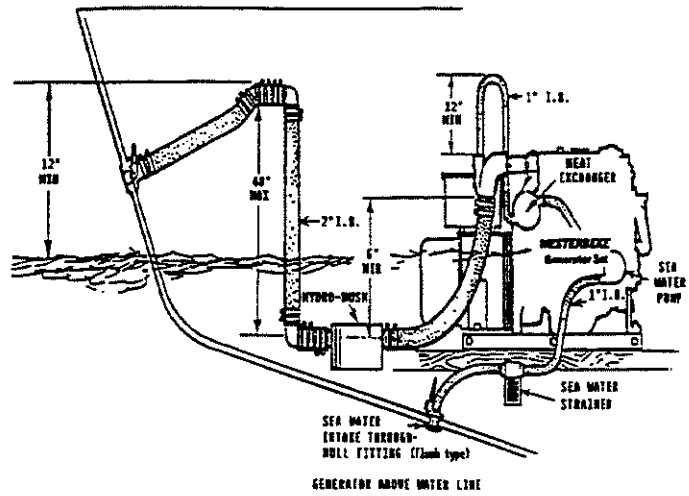
- Dizziness
- Intense Headache
- Weakness and Sleepiness
- Vomiting
- Muscular Twitching
- Throbbing in Temples

The generator *must* have its own separate exhaust installed so that the entry of raw water into the engine's exhaust manifold and cylinders is prevented while the engine is not running, or while the vessel is under sail or power in which case the vessel may experience heeling, backing down from following seas, or any other condition. Special attention *must* be taken to make certain the exhaust system is secure, tight and free of leaks.

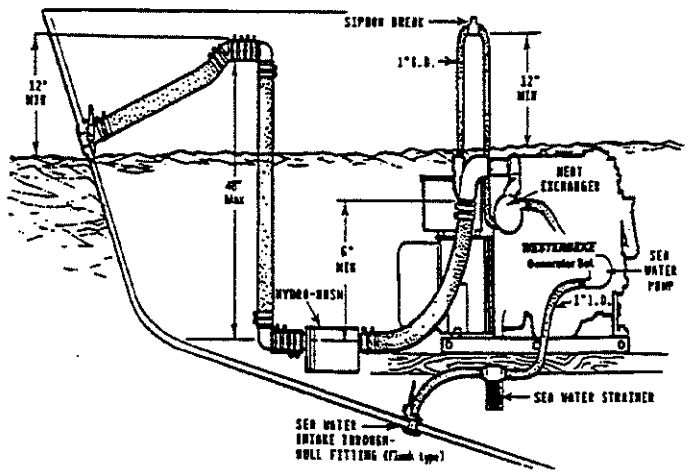
The raw water supply through-hull sea cock fittings *must* be of the flush-hull type. High-speed scoop types or weedless scoop types must not be used, as they tend to encourage siphoning.

When a water lift type exhaust system is used, the exhaust muffler should be mounted as close to the engine as practical. The exhaust discharge should always drop downward into the exhaust muffler. Loops in the exhaust hose between the water-injected exhaust elbow and the water lift muffler should be avoided, as these will trap and hold water.

For installations where the exhaust manifold/water-injected exhaust elbow is within 8 inches or below the vessel's water line, provisions *must* be made to install a siphon-break or a vent in the raw water supply hose to the water-injected exhaust elbow. This stops the flow of raw water that runs through the raw water cooling system from filling the exhaust and engine cylinders when the engine is shut down. This raw water supply hose *must* be looped above the water line and the siphon-break or vent *must* always be above the water line during all angles of vessel operation to prevent siphoning. The vent, when used, must have its vent hose or tube routed so it can remain above the water line and empty of water when the engine is shut down. This allows air to enter through this vent to prevent siphoning.



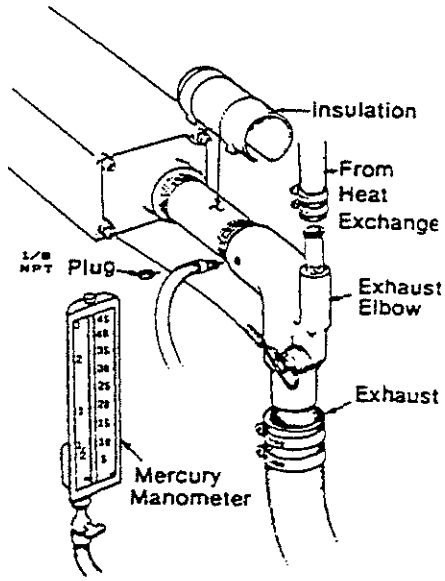
GENERATOR ABOVE WATER LINE



GENERATOR BELOW WATER LINE

Exhaust Back-Pressure

The exhaust discharge hose must be of adequate size and minimal run to prevent excessive exhaust back-pressure. Exhaust back-pressure should be checked before a generator is put into service. (Refer to illustration.) Excessive back-pressure will affect the engine's performance which affects generator AC power output.

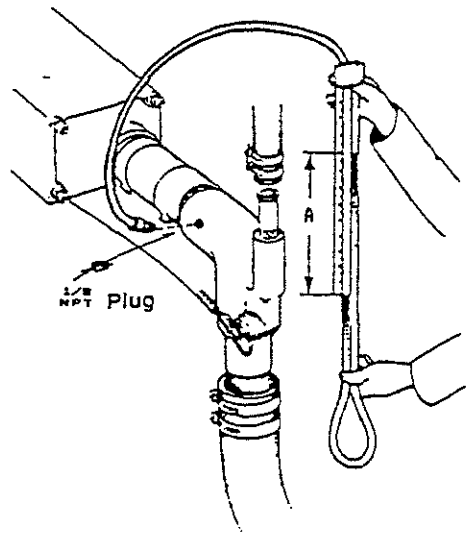


To measure for back-pressure, use a mercury manometer, a pressure gauge, or a water column. A boatyard or marine mechanic should have a manometer or a pressure gauge. If the generator set does not have a tapped hole in its exhaust elbow, one must be drilled and tapped for a 1/8 inch NPT fitting in the dry area of the elbow.

A water column can be made by taking a clear plastic tube and taping one end of the tube along a yardstick and fitting the other end of the tube with a 1/8 inch NPT (National Pipe Tap) pipe fitting.

Measure the engine's back-pressure at the exhaust elbow while the generator is under a full-load.

Refer to the pressure specifications listed below.



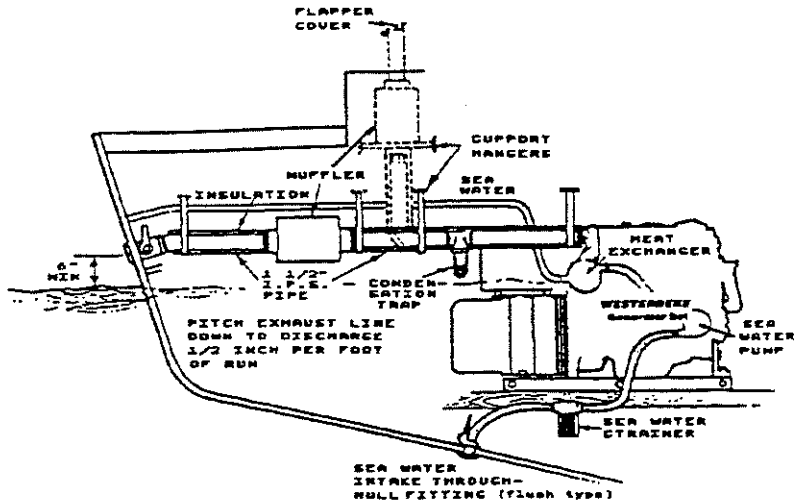
Dimension A cannot exceed 39 inches of water.

Back pressure, as measured by a gauge instrument, should not exceed the following specifications:

2 inches of mercury
27 inches of water in a water column
15.6 ounces PSI
1.0 PSI

Excessive back-pressure can be caused by a small diameter exhaust hose, a small muffler, sharp bends in the exhaust hose, improper fittings, water pockets, and a high volume of water in the exhaust system due to the length of the exhaust discharge hose. The use of elbows and fittings in the exhaust discharge hose's routing should be limited since these will create flow restrictions and contribute to exhaust back-pressure. The generator's exhaust system must be separate from any other engine' s exhaust system. Dry portions of the exhaust system between the engine's exhaust manifold and the water injected exhaust elbow must be insulated to hold in the heat.

Dry stack-type exhaust systems (shown to the right) must be attached to the generator engine's exhaust manifold by means of a flexible connector pipe. This system must be properly supported, insulated, and routed so as not to allow water to enter the engine's cylinders by coming in through this piping. Provisions must be made for discharging the engine's raw cooling water overboard.



DRY STACK EXHAUST

Exhaust System Failures

When the engine's raw water is fed into an exhaust system so that the full stream of this water strikes a surface, erosion takes place. This erosion may cause premature failures. The proper design of either a water jacketed or water injected "wet" exhaust system to prevent this problem requires that the raw water inlet be positioned so that the entering stream of raw water does not directly strike a surface. In addition, the velocity of the entering raw water stream should be as low as possible, which can be achieved by having inlet fittings as big in diameter as possible.

The best protection against carbon monoxide poisoning is a daily inspection of the complete exhaust system. Check for leaks around manifolds, gaskets, and welds. Make sure exhaust lines are not heating surrounding areas excessively. If excessive heat is present, correct the situation immediately. If you notice a change in the sound or appearance of the exhaust system, shut down the unit immediately and have the system inspected and repaired at once by a qualified mechanic.

Make sure there are no unnecessary objects suspended from any portion of the exhaust lines. Rigidly constructed exhaust risers installed off the exhaust manifold **must not exceed 8 lbs** in total weight. Excessive unsupported weight could cause deflection or distortion of the manifold resulting in damage and/or internal leaks. Rigidly constructed riser assemblies that do exceed 8 lbs. must be supported to the engine, not to the hull. Inspect insulated portions of the exhaust system to ensure there is no deterioration of the insulation.

CAUTION

Prolonged cranking intervals without the engine starting can result in filling the engine-mounted exhaust system with sea water coolant. This may happen because the sea water pump is pumping sea water through the sea water cooling system during cranking. This sea water can enter the engine's cylinders by way of the exhaust manifold once the exhaust system fills. Prevent this from happening by closing the sea water supply through-hull shut-off, drain the exhaust muffler, and correct the cause for the excessive engine cranking needed to obtain a start. Engine damage resulting from this type of sea water entry is <u>not</u> a warrantable issue; the owner/operator should keep this in mind.

Exhaust Elbow Installation

The Westerbeke Corporation offers a 45° and 90° exhaust elbow as well as an exhaust riser you can install on your engine. Refer to the instructions below when installing the exhaust elbow purchased.

NOTE: Fabricated exhaust elbows or risers attached to the exhaust manifold **must not exceed 8 lbs when unsupported.**

1. Coat only one side of the exhaust gasket with ***High Tack*** adhesive sealant (manufactured by Permatex Company, Brooklyn, NY). Place this coated surface against the exhaust manifold's exhaust port flange (the gasket should stick to the flange without falling off).

2. Place the clamp over the elbow's flange. Place your exhaust elbow against the exhaust manifold's flange so the exhaust manifold's flange rests snug against the exhaust elbow's flange with the gasket centered between the two. Now slip the exhaust clamp over both flanges.

3. Tighten the clamp just enough so the exhaust elbow can remain attached to the manifold and still be rotated.

The exhaust elbow discharge ***must*** be directed ***downward*** so the mixture of raw water and exhaust gases will flow/fall downward into the exhaust muffler which ***must*** be positioned below the exhaust elbow. There should be no loops or rises in the exhaust hose connected between the exhaust elbow and the muffler, as these would trap water and possibly allow water to flow back into the engine during starting or at shut down.

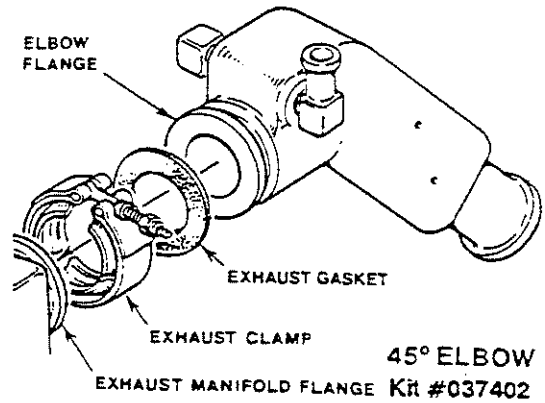
4. Adjust the elbow by rotating it until the desired alignment with the exhaust piping is acquired.

5. Carefully tighten the clamp between 8 to 10 lb-ft, or 96 to 120 lb-in., or 1.1 to 1.3 kg-m.

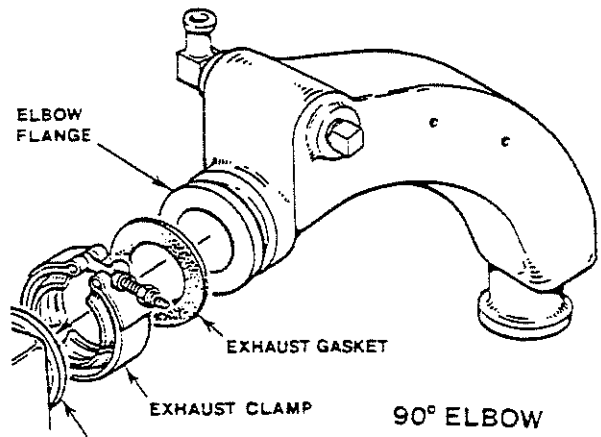
CAUTION

Approach the 10 lb-ft torque limit with caution. The clamp's threads will break if more than 10 lb-ft is applied to the clamp.

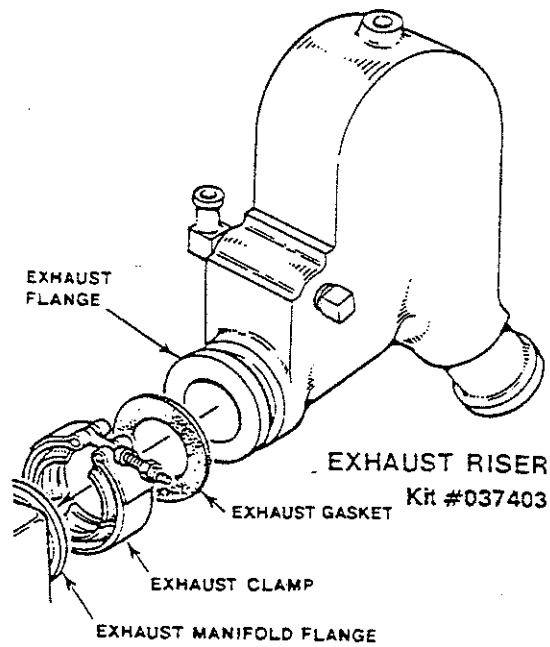
If a leak exists, correct it immediately.



45° ELBOW Kit #037402



90° ELBOW Kit #037401



EXHAUST RISER Kit #037403

FUEL SYSTEM

The generator must have its own fuel supply line; in other words, it must have its own pickup tubes and primary filter/water separator. **DO NOT TEE OFF OF ANOTHER ENGINE'S FUEL SUPPLY.** The fuel system should be installed in such a manner as to allow the engine-mounted fuel lift pump to maintain a positive inlet pressure to the injection pump under all operating conditions. The minimum size of the fuel supply line and fuel return line is 1/4 inch, inside diameter, and there should be a primary fuel filter installed between the fuel tank and the fuel lift pump. Only one fuel filter is installed on the engine, between the fuel tank and the fuel lift pump. Only one filter is installed on the engine, between the fuel lift pump and the injection pump; this filter has a replaceable element.

The fuel tank's fuel pick up tube should be clear and unobstructed. No screens or gauze strainers should be incorporated in the fuel pickup tube. Make sure the fuel supply and return lines are secureley anchored to prevent chafing and that all fittings are sufficiently tightened to prevent leakage. Also, make sure your fuel system has a positive shut-off valve; know its location and how it operates. Do not use a mechanical check valve for this function.

It is recommended that an approved filter/separator be used in the fuel supply between the fuel tank and the generator's engine to help remove contaminants in the fuel before the fuel reaches the engine-mounted fuel lift pump and injection pump.

The fuel return at the tank should extend down into the tank in the same manner as a pickup tube. This practice is particularly important in installations where fuel tanks are installed below the engine's fuel system and will help prevent air from entering the fuel system when the engine is shut down. Ensure that the fuel tank filler is properly sealed to prevent water entry should it become awash. The fuel tank's vent should be located so that its discharge route cannot allow water to enter through to the fuel tank(s). Moisture must no be allowed to accumulate in the vent's line.

Be sure that there is a fire extinguisher installed near the unit and that is properly maintained. Be familiar with its use. An extinguisher with the NFPA rating of ABC is appropriate for all applications in this environment.

OIL DRAIN

An oil sump drain hose is installed on the engine with the discharge and secured by a bracket at the front of the engine. Oil may be drained from this hose by removing the cap and the discharge end of the hose from the support bracket and lowering the hose into a container. The hose cap fitting is 1/4 inch NPT and can be extended, or have a pump added, for easier removal of the old oil, if desired.

CONNECTING PRESSURE SENSING DEVICES TO OIL GALLERIES

Oil pressure sensing devices, such as senders and switches, must no be connected to an engine's oil gallery with the use of extended nipples or tees. The reason is simply that continued engine vibration causes fatigue of the fittings used to make such a connection. If these fittings fail during engine operation, lubricating oil will be lost and internal engine damage will result.

When additional sensing devices such as senders and switches need to be installed, these devices *must* be bulkhead-mounted and connected to the oil gallery using an appropriate grade of lubricating oil hose. Any fittings used to connect the hose to the oil gallery *must* be of steel or malleable iron composition. ***Brass must not be used for this application.***

Raw Water Intake System

Make sure the intake system (raw water cooling system) is in proper order. Check that the hull inlet, sea cock and strainer are unobstructed. Sea cocks and strainers should be at least one size greater than the inlet thread of the sea water pump. The strainer should be of the type that may be withdrawn for cleaning while the vessel is at sea and should be mounted below the water line to ensure self-priming. Inspect the raw water lines to make sure there are no collapsed sections, which would restrict water flow. Make sure there are no air leaks at any of the connections.

Cooling System

The generator's engine is fresh water-cooled by an engine-mounted heat exchanger. Raw water is used as the heat exchange's cooling medium. Raw water is pumped into the exchanger by a raw water pump and is then injected into the exhaust discharge, carrying with it the heat removed from the engine's fresh water cooling system.

Raw water should be supplied to the raw water pump through a flush-type through-hull fitting using a wire-reinforced hose between the through-hull fitting and the raw water pump. This raw water should be directed through a visual-type raw water strainer and then delivered to the pump. Hoses routed from the through-hull fitting to the strainer and to the raw water pump should be wire-reinforced to prevent the hose from collapsing during the generator's operation (suction from the pump may collapse a non-reinforced hose). Raw water strainers should be mounted at or below the water line to make sure the raw water line remains primed after shutdown.

CAUTION

Do not use a scoop-type through-hull fitting as a means of supplying raw water to the generator. Water pressure against this type fitting, while the vessel is under way, can push raw water past the raw water pump's impeller into the generator's exhaust system, filling it and the engine as well. Flush-type, clear, through-hull fittings are recommended and should be located on the hull so as to be below the waterline during all angles of boat operation.

The use of common-type street elbows is not recommended for plumbing the raw water circuit. These generally have very restrictive inside diameters. Machined fittings are preferred.

Electrical System

The electrical system should be checked to make sure all wiring harnesses are properly tied down with clamps or plastic ties and that all wiring harnesses are spaced at intervals close enough to prevent chafing from vibration. Check to make sure all engine harness connections are tight and that they are made to the appropriate terminals.

DC Electrical Connections

A common ground for the negative (-) DC terminal connection is found at the bell housing of the generator, next to the starter, in the form of a threaded grounding stud. The battery ground should be connected at this stud.

Connect the battery's positive (+) connection to the starter solenoid tagged for this connection.

CAUTION

To avoid an overcharging condition, and a possible equipment failure, **do not** disconnect the DC battery source while the engine is running.

Automatic Shutdown

High Exhaust Temperature Shutdown Switch (normally closed)

An exhaust temperature is located on the exhaust elbow. Should the switch's sensor indicate an excessive exhaust temperature, the switch will open and shut the generator off (an inadequate supply of raw water coolant causes high exhaust temperatures). This switch opens at 260 - 270°F (127 - 132° C) resets at approximately 225°F (107°C).

High Water Temperature Shutdown Switch (normally closed)

A high water temperature switch is located on the thermostat housing. Should the fresh water coolant's operating temperature reach approximately 205° F (96°C), the switch will open and shut the generator off. This switch resets at 195°F (107°C).

Low Oil Pressure Shutdown Switch (normally open)

A low oil pressure shutdown switch is located off the engine's oil gallery. The switch's sensor monitors the engine's oil pressure. Should the engine's oil pressure fall to 5 - 10 psi, the switch will open and turn the generator off.

Generator (AC Output)

Make sure that the AC output connections within the generator's AC terminal block are correct and in accordance with the specific AC Load Connections diagram found later in this manual. (See the "BT GENERATOR" section of this manual.) Make sure the AC leads are protected against chafing as they exit the generator housing.

WARNING

Do not smoke or allow an open flame near batteries. Lead acid batteries emit hydrogen, a highly-explosive gas.

Batteries

Make sure the positive (+) battery connection is connected to the battery connection of the starting solenoid. The negative (-) battery connection should be connected to the ground stud tagged at the rear of the engine block.

WARNING

When servicing the battery or checking the electrolyte level, wear rubber gloves, a rubber apron, and eye protection. Battery acid may splash on the skin or into the eyes inadvertently when removing the electrolyte caps.

Check the battery's electrolyte level and specific gravity to ensure maximum engine starting efficiency. Make sure the battery's terminals are clean and tight.

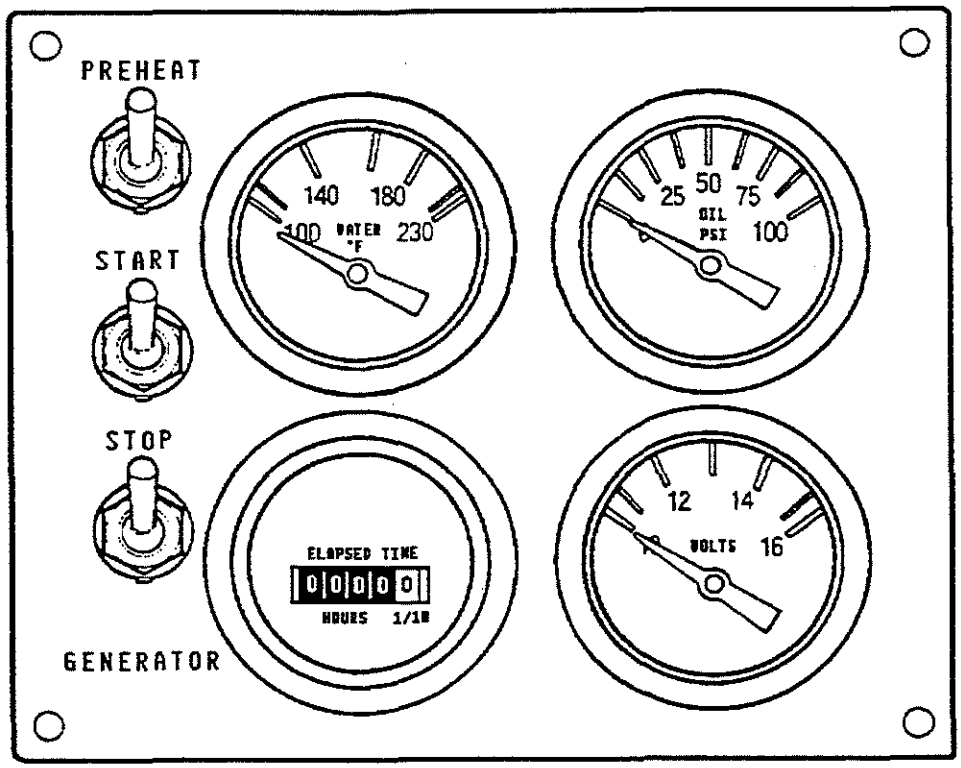
Ventilation

The ventilation requirements of the generator sets include the following: combustion air is required for the engine cylinders; cooling air is required for the generator end and also for removing the heat produced by the generator's engine during operation; and ventilating air is required to clear the bilges below the generator, as well as the compartment in which the generator is located, of potentially toxic and flammable diesel vapors.

Keep in mind that hot air rises, so heated air should be removed from the upper area of the generator compartment and cool fresh air should be directed to the lower areas of the compartment. Ventilation should be accomplished with the aid of blowers especially when the vessel is not underway. Refer to the "SYSTEM SPECIFICATIONS" section of this manual for the airflow requirements of the generator set.

NOTES

DESCRIPTION OF INSTRUMENT PANEL



General

The manually operated series of Westerbeke generators is equipped with toggle switches and optional remote panels. The Standard Instrument Panel (shown above) includes two gauges which indicate water temperature in degrees Fahrenheit (WATER °F) and oil pressure in pounds per square inch (OIL PSI). This panel is also equipped with two meters which indicate DC control circuit voltage (VOLTS) and the generator's running time (ELAPSED TIME) in HOURS and in 1/19 hours. The water temperature and oil pressure gauges and the DC volt meter are illuminated; the ELAPSED TIME meter is not illuminated.

1. PREHEAT: The PREHEAT switch energizes the engine's glow plugs, activates the electric fuel pump, bypasses the engine's oil pressure switch, and activates the fuel run solenoid. In addition, this switch energizes the START switch.

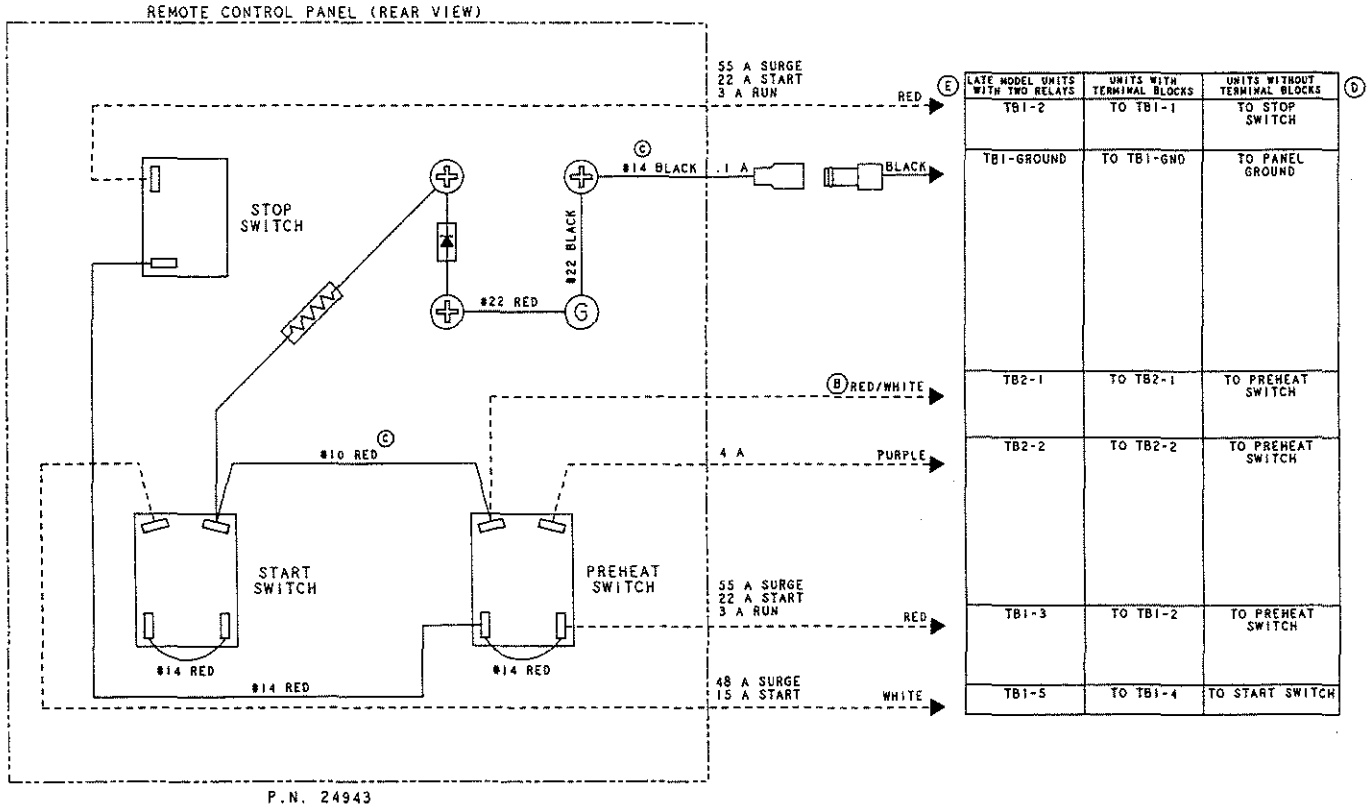
2. START: The START switch, when pressed, energizes the starter's solenoid which cranks the engine. This switch will not operate electrically unless the PREHEAT switch is pressed and held at the same time.

3. STOP: Through the STOP switch power is provided to the fuel solenoid. Opening this switch deactivates the fuel solenoid and shuts off fuel to the engine, thereby stopping the engine.

NOTE: When the engine is manually shut down, the water temperature gauge and oil pressure gauge will continue to register the last temperature reading and oil pressure reading indicated by the gauge before electrical power was turned off. The temperature gauge and oil pressure gauge will return to zero once electrical power is restored to these gauges.

Remote Operation

For starting and stopping the generator at a remote location, the same three switches are used. The PREHEAT and START switches are connected in parallel with the local panel's switches and serve the same functions as in the local panel. The STOP switch is connected in series with the local panel's STOP switch and serves the same function as in the local panel. The generator may be stopped from local or remote positions.



Refer to the control circuit wiring diagram when installing the remote start/stop panel.

NOTE: Reference the DC wire sizing chart on the following page for wire sizes connecting between the engine panel and remote.

DC WIRE SIZING CHART
Stranded Conductors for 12 Volt Circuits
10% Voltage Drop

A. Society of Automotive Engineers Type Wire									B. National Electrical Code Type Wire								
Wire Size	18	16	14	12	10	8	6	4	16	14	12	10	8	6	4	2	1
Standing	16x30	19x29	19x27	19x25	19x23	19x21	49x23	49x21	19	19	19	19	19	37	61	127	127
Circular Mil Area	1537	2336	3702	5833	9343	14810	25910	37360	2583	4107	6530	10380	16510	26250	41740	66370	83690
Circuit Current In AMPS			Maximum Length of Conductor in Feet from Power Source to Load and Return														
1.	174	260							285								
2.	87	130	210	330					142	227							
3.	58	86.7	140	220					94.6	151	240						
4.	43.7	65	105	165	262				71	113	180	285					
5.	34.7	52	84	132	210				57	57	143	232					
6.	29	43.3	70	110	175	279			47.3	75.3	120	190	303				
7.	24.7	37	60	94	150	240			40.7	64.7	103	163	260				
8.	21.7	32.7	52.7	82.7	131	210			35.3	56.3	89.6	143	227				
9.	19.3	28.7	46.7	73.3	116	186	300		31.7	50.3	79.6	127	202	321			
10.	17.3	26	42	66	105	168	271		28.3	45.3	72	114	182	289			
15.		17.3	28	44	70	112	180	285	19	30	48	76	121	193	306		
20.			21	33	52.7	83.7	135	211		22.7	36	57	91	145	230		
30.				22	35	56	90.3	142			24	38	60.7	96.3	153	243	306
40.					26.3	42	67.3	107				28.3	45.3	72	115	182	230
50.					21	33.7	54	85.3				23	36.3	57.7	92	146	184
55.						30.7	49	77.7					33	52.3	83.3	133	167
60.							45	71.3						48	76.3	121	153
75.							36	57						38.3	61	97.3	123
90.								47.3							51	81	102

The voltage drop for specific conductor lengths may be calculated by the formula:

$$\text{Voltage drop} = \frac{10.75 \times I \times L}{CM}$$

where: I = load in amperes
L = conductor length in feet
CM = conductor circular MIL area

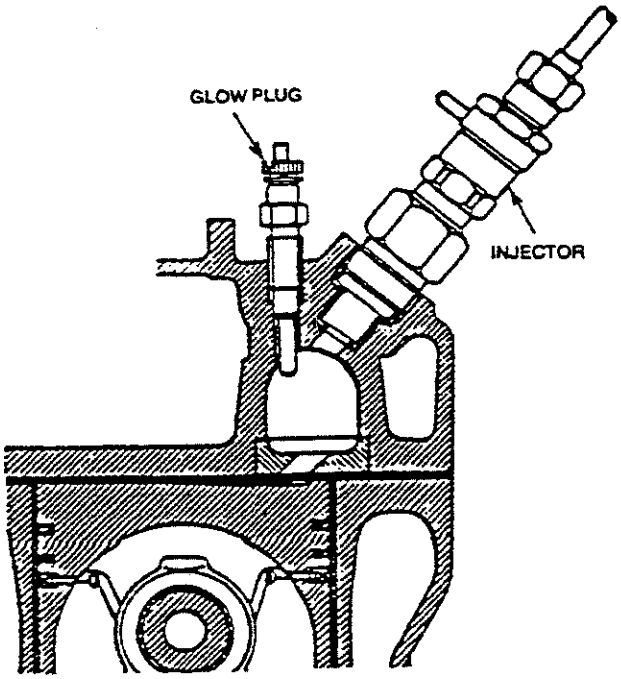
When a circuit, including the ground return, uses several different size conductors, the voltage drop at the electrical device is the sum of the drops calculated for each size segment of the circuit.

Description of Starting System

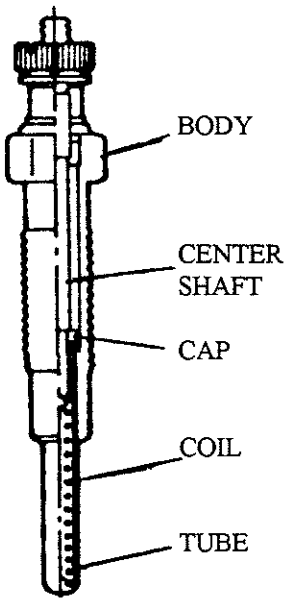
Westerbeke diesel engines use electric starters assisted by glow plugs for both normal and cold weather starting. The figure below shows a cross-sectional view of one cylinder. The glow plug is located in the combustion chamber so that its tip is in the injector nozzle's spray path. When the glow plug is energized by the PREHEAT button, the plug glows red at the tip and assists in igniting the fuel. The result is a rapid start with less wear on the starter.

This system is common to Westerbeke Diesels. The start circuitry is designed so that the PREHEAT button *must* be depressed for the time specified in the "Preheat" chart. Then, while keeping the PREHEAT button engaged, the START button is depressed to crank the engine.

Combustion Chamber



Glow Plug



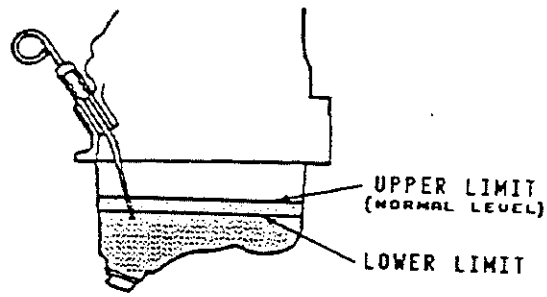
NOTE: The START switch will not energize unless the PREHEAT button is depressed. When depressing the preheat switch, we are activating the glow plugs in the cylinder head so use the preheat intermittently to avoid overheating the glow plugs.

PREPARATION FOR STARTING

This section of the manual provides the operator with preparation, initial starting, break-in, starting (cold or warm) and stopping procedures. Follow the procedures as presented, for the conditions indicated, and your Westerbeke generator set will give you reliable performance and long service life.

Take the steps described below in starting your engine for the first time or after a prolonged shutdown or lay-up.

Fill your engine with oil up to or near the upper limit on the dipstick (the installation angle may have an affect on the dipstick reading). Select readily available lubricating oil with an API specification of CC or CD and an SAE number suitable for the temperature in your operating area. For the quantity of oil needed in your engine, refer to the "System Specifications" section of this manual.



Fill the tank with a good grade of No. 2 diesel fuel and prime the fuel system up to the engine. When returning fuel is free of air, the engine's fuel system is bled and the engine is ready to start.

Each unit is supplied with a coolant recovery kit (#24977) as standard equipment which *must* be installed and the following applies:

A. Remove the pressure cap from the engine's exhaust manifold and slowly fill the engine's cooling system with a mixture of water and antifreeze suitable for your temperature zone. Operate the engine and observe the coolant level in the manifold. Maintain this level to the base of the filler neck. Once the engine reaches its operating temperature (170 - 190°F), make sure there is no problem with a coolant flow through the manifold. Top off the cooling system and install the pressure cap.

B. Make sure the plastic recovery tank is properly mounted near the unit (with the bracket provided), in a location where it can be monitored and filled easily. The recovery tank should be mounted at manifold level or above. In these installations that require it, the plastic recovery tank can be mounted below the exhaust manifold's level. Fill this tank half full.

C. Monitor the coolant level in the plastic recovery tank daily and add coolant as needed. Some coolant will be lost through evaporation. This will be minimal. Periodically check that the manifold is full of coolant when the system is cold.

Make sure the Installation Checks have been made in accordance with those specified in the "Installation Checks" section of this manual

STARTING PROCEDURE

1. Depress and hold the preheat switch. Preheat according to the following chart.

2. While still depressing the PREHEAT switch, depress the START switch. As soon as the engine runs, release the START switch but continue to hold the PREHEAT switch depressed for an additional 2 - 3 seconds. This allows the engine to build up enough oil pressure to close the oil pressure shutdown switch and allow the engine to continue to run.

> NOTE: Should the engine not start when the START switch is depressed for 10 - 12 seconds, release both switches and wait 30 seconds; repeat the previous procedure. Never run the starter motor for more than 30 seconds at a time.

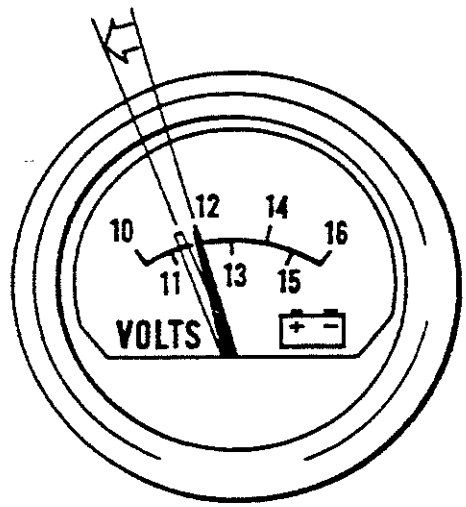
3. Check all instruments on the panel for proper operation. Make sure raw water discharges with the exhaust discharge.

Atmospheric Temperature	Preheating Time
+41° F (+5° C) or higher	Approx. 10 sec.
+41° F (+5° C) to + 23° F (-5° C)	Approx. 20 sec.
+23° F (-5° C) or lower	Approx. 30 sec.
Limit of continuous use	30 seconds before cranking

Once the engine starts, allow it to run for a few minutes to warm up and stabilize while the engine's instruments are checked for proper oil pressure and battery charging voltage. Never attempt to engage the starter while the engine is running.

> NOTE: Some unstable running may occur in a cold engine, but this condition should smooth out as the operating temperature of 130 - 150° F (55 - 56° C) is reached.

Proper glow plug function is indicated by a voltmeter drop when the PREHEAT switch is depressed. This drop will be slight but discernible. If no voltage drop is noted, it may indicate defective glow plugs or a faulty preheat circuit (check for loose connections).



CAUTION

Prolonged cranking intervals without the engine starting can result in filling the engine-mounted exhaust system with sea water coolant. This may happen because the sea water pump is pumping sea water through the sea water cooling system during cranking. This sea water can enter the engine's cylinders by way of the exhaust manifold once the exhaust system fills. Prevent this from happening by closing the sea water supply through-hull shut-off, drain the exhaust muffler, and correct the cause for the excessive engine cranking needed to obtain a start. Engine damage resulting from this type of sea water entry is <u>not</u> a warrantable issue; the owner/operator should keep this in mind.

Engine Break-In Procedure

Although your generator has experienced a minimum of one hour of test operations to make sure accurate assembly procedures were followed and that the generator operated properly, a break-in time is required. The service life of your engine is dependent upon how the engine is operated and serviced during its initial hours of use.

Your new engine requires approximately 50 hours of initial conditioning operations to break in each moving part in order to maximize the performance and service life of the engine. Perform this conditioning carefully, keeping in mind the following:

1. Start the generator according to the "STARTING PROCEDURE" section. Run the engine while checking that all systems (raw water pump, oil pressure, battery charging) are functioning.

2. Start the generator and allow the engine to warm up until the water temperature gauge moves into the 130 - 140° F range.

3. Use caution not to overload the generator. The presence of a gray or black exhaust with loss of engine rpm (hertz) are signs of a possible overload.

4. Run the generator at 1/2 of its rated capacity for the first 10 hours then increase the load to 3/4 of its rated capacity. For the remainder of the break-in period, the generator may be run at different load intervals.

Breaking-in a new engine basically involves seating the piston rings to the cylinder walls. Excessive oil consumption and smoky operation indicate that the cylinder walls are scored, which is caused by overloading the generator during the break-in period.

As indicated above, operate the generator with a moderate load during the 50 hour break-in period. (On one hand don't baby the engine, but on the other hand, don't abuse it.)

Remote Starting Procedure

The remote start panel is the same as the engine-mounted start panel except that it has a green LED light. When starting at a remote location, the green LED lights faintly when the preheat is depressed. It will dim or flicker when the start switch is depressed and the starter cranks the engine. Once the engine starts the green LED will glow bright signaling to release the start switch in that the starting of the generator may not be audible at the remote start/stop panel location.

A. When starting the generator set at a remote location, release the START switch when the green LED lights bright but continue depressing the PREHEAT switch. After releasing the START switch, continue holding the PREHEAT switch until the oil pressure is sufficient to close the oil pressure safety switch providing the normal B+ path to the fuel run solenoid. This will be just a few seconds.

B. After the generator is started and the starter switch is released, the generator's starter will not crank until someone again operates the PREHEAT switch first because this switch supplies voltage to the START switch.

Starting Under Normal Conditions

Follow the procedure below for normal starting of the generator.

1. Make sure there is sufficient fuel on board. Keep fuel tank(s) as full as possible. Check the fuel filters and water separators for the presence of contaminants and/or water. Drain and clean them as needed.

2. Check the coolant level in the plastic recovery tank. Add coolant solution as needed.

NOTE: Excessive loss of coolant from the plastic recovery tank indicates a cooling system leak. Check the entire cooling system and pressurize the system using a common automotive radiator pressure tester to locate the leak. In cases of excessive coolant loss, the system *must* be refilled as outlined under the "PREPARATION FOR STARTING" section of this manual.

3. Check the oil level in the engine sump and look for fuel leaks, particularly if signs of such leaks are found on the bottom of the engine or below the engine.

Start the generator in accordance with the "STARTING PROCEDURE" instructions in this manual and allow the engine's operating temperature to reach 140 - 150° F before placing a load on it.

Starting Under Cold Conditions

Under extremely cold temperatures, the following conditions can occur. Follow the instructions listed below when operating your engine in cold weather.

Lubricating Oil Turns Viscous - Make certain that the lubricating oil used conforms with the ratings for the prevailing atmospheric temperature. Refer to the "LUBRICATING SYSTEM" section of this manual for an atmospheric/oil viscosity specification table.

Voltage Across the Battery Terminal Drops - Make certain that the battery is fully charged to minimize voltage drop across the battery terminals.

The Temperature of the Intake Air is Low and the Compression Temperature does not Rise Enough - Allow the glow plugs to operate sufficiently to aid in starting during the preheat period whenever the temperature of the intake air is low and when the compression temperature does not rise enough. Refer to the preheat chart found in the "STARTING PROCEDURE" section of this manual.

STOPPING PROCEDURE

1. Remove the AC electrical loaf from the generator and allow the generator to run for 3 to 5 minutes to stabilize its operating temperature.

2. Depress the STOP switch and hold it until the generator is completely stopped.

3. Now release the STOP switch.

Remote Stopping Procedure

To stop the generator, depress the STOP switch which opens the normally closed B+ path for voltage to the engine's run circuit. The bright green LED will go dim/faint when the generator slows and stops. Then it will go out, indicating the engine has stopped. The STOP switch must be held open until the generator comes to a complete stop. Remote start panels may be connected to the generator set as indicated. A jumper has to be removed between the T-1 and T-2 connections at the panel connection terminal board. (Refer to the wiring diagram in the "ELECTRICAL SYSTEM" section of this manual for remote start/stop panel connections.)

NOTES

FUEL SYSTEM

Diesel Fuel

Use No. 2 diesel fuel with a cetane rating of 45 or higher. Never use kerosene or home heating oil since these fuels do not have the same lubricating properties as No. 2 diesel fuel.

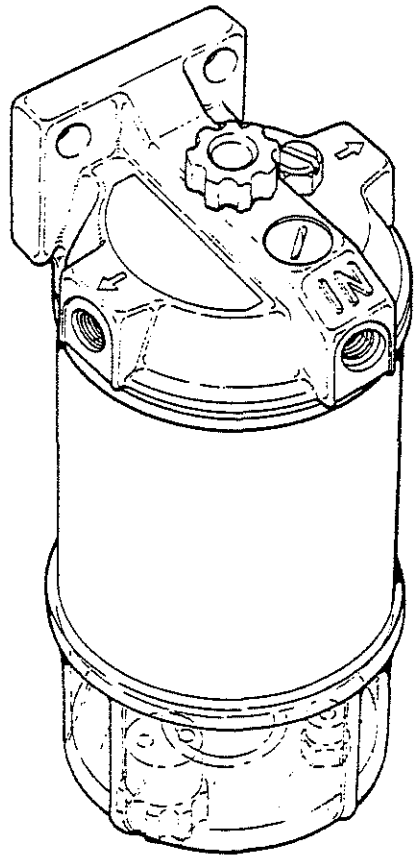
In cold weather particularly, water vapor is produced by condensation when air is present in the fuel tank. Keep fuel tank(s) full and completely free of dirt and water.

Fuel Filter/Water Separators

A primary fuel filter of the water separating type *must* be installed between the fuel tank and the engine. This is to remove water and other contaminants from the fuel before they can be carried to the fuel system on the engine.

Most installers include with the generator installation package a type of filter/water separator for they are aware of the problems contaminants in the fuel can cause - all of which are not warrantable through Westerbeke.

A typical fuel filter/water separator is illustrated at the right. This is the Raycor Model 220 F. Keep in mind that if a water separator type filter is not installed between the fuel supply tank and engine-mounted fuel system, any water in the fuel will affect the fuel pump, engine filter, and injection equipment. The owner/operator is responsible for making certain the fuel reaching the engine's injection equipment is free of impurities. This process is accomplished by installing and maintaining a proper filtration/separation system.



In addition, any gasoline in the fuel system will damage the engine's fuel injection pump assembly and injectors as gasoline does not have the same lubricating qualities as diesel fuel.

Priming the Fuel System (Self-Bleeding)

The Westerbeke self-bleeding fuel system is semiautomatic in operation. The self-bleeding feature of the fuel system allows for easy servicing of the fuel filters. Simply remove and replace the filter element (take care in catching any fuel that may drain out of the fuel filtering assembly as described in the "Replacing the Fuel Filter Element" section. Energize the PREHEAT switch to allow the electric fuel pump to operate for 20 to 30 seconds to prime and bleed air from the system. (No fittings should be opened.) Then proceed to start the engine as you normally would. If the engine does not start, stop and wait a few moments, and then repeat the bleed procedure as indicated below. When the PREHEAT switch is depressed, the preheat elements (the glow plugs) are energized, so take care not to overheat them.

CAUTION

Prolonged cranking intervals without the engine starting can result in filling the engine-mounted exhaust system with sea water coolant. This may happen because the sea water pump is pumping sea water through the sea water cooling system during cranking. This sea water can enter the engine's cylinders by way of the exhaust manifold once the exhaust system fills. Prevent this from happening by closing the sea water supply through-hull shut-off, drain the exhaust muffler, and correct the cause for the excessive engine cranking needed to obtain a start. Engine damage resulting from this type of sea water entry is not a warrantable issue; the owner/operator should keep this in mind.

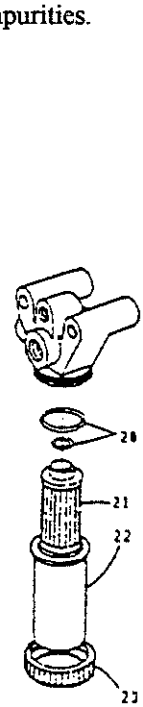
Replacing the Fuel Filter Element

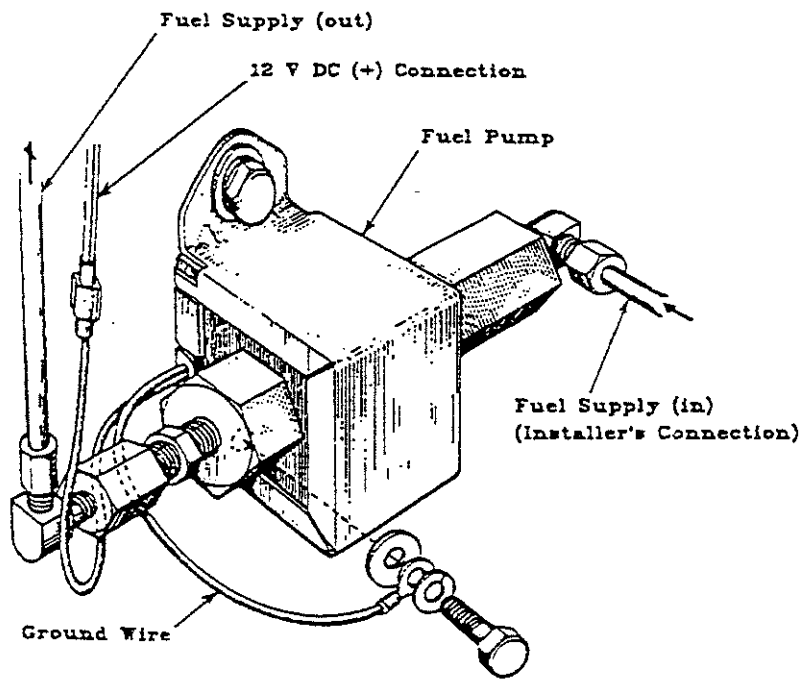
While it is unlikely that the operator will be forced to service the system at sea, the possibility does exist. Therefore, it is recommended that banjo washers, injector sea washers, a fuel system hardware kit, fuel filter and gasket be carried on board at all times. Select the parts for your engine from the Parts List and purchase spares from your local Westerbeke Dealer or Distributor. For example, filter kit #30200 includes replacement elements with gaskets (items #21 and 20). If a leak should develop at a fuel banjo or sealing washer location that cannot be remedied by a slight tightening, the sealing washers and banjo bolts contained in the fuel system hardware kit for your particular model will come in handy to remedy these leaks.

After the first 50 hours of operation, loosen retainer ring #23 and discard filter element #21. Clean bowl #22 and install a new filter using a new #20 gasket. Be careful to catch any fuel that may spill form within these fuel assemblies.

After the first 50-hour change, the change period may be increased to 200 hours or once per season.

The fuel pump has no filter element within it. The only maintenance it requires is to ensure the connections to it, both fuel and electrical, are secure and tight and that fuel supplied to this pump is free of impurities.

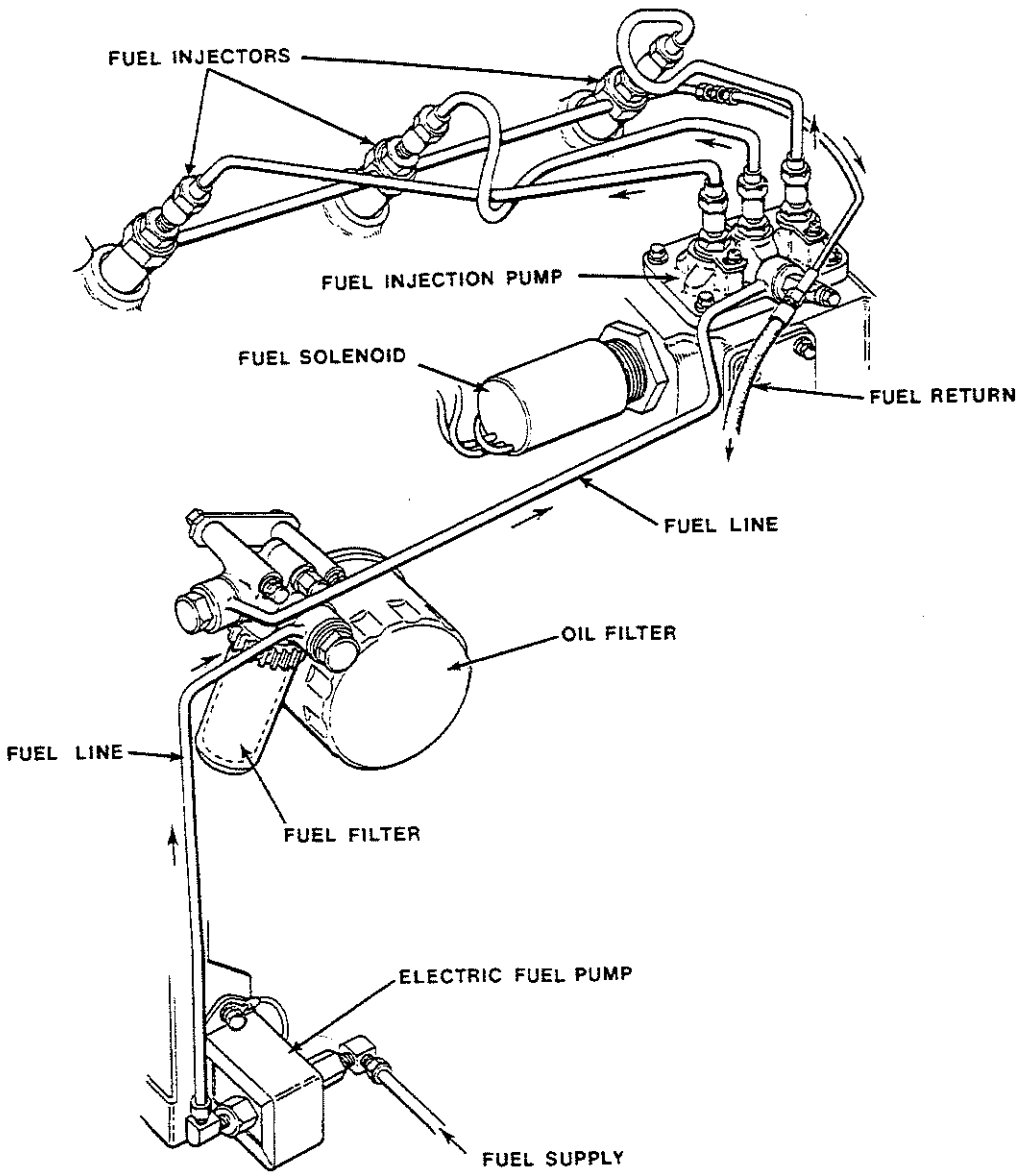




Fuel Injection Pump

The illustration below shows the 7.6 KW BTD's fuel system. The fuel injection pump, located to the right, is one of the most important components of the diesel engine and, therefore, calls for the utmost caution in handling. Furthermore, the fuel injection pump has been thoroughly bench-tested and should not be tampered with.

Speed (hertz) and timing adjustment are the only adjustments the servicing dealer can perform on the injection pump. Other types of adjustments or repairs *must* be performed by a qualified injection service shop.



To obtain long and satisfactory service from the injection pump, always use fuel which is free from impurities and maintain a good filtration and water separation system between the fuel tank and engine. Service this system regularly: the injection pump it saves will be your own.

DC ELECTRICAL SYSTEM

Engine 12-Volt DC Control Circuit

The Westerbeke 7.6 KW BTD generator has a 12-volt DC electrical control circuit, as shown on wiring diagram #039284. Refer to this diagram when troubleshooting or servicing electrical components on the engine.

CAUTION

To avoid damage to the battery charging circuit, never shut off the engine battery switch while the engine is running.

Shut off the engine battery switch, however, to avoid electrical shorts when working on the engine's electrical circuit.

Battery Specification

The minimum recommended capacity of the battery used in the engine's 12-volt DC control circuit is 350--400 cold cranking amps.

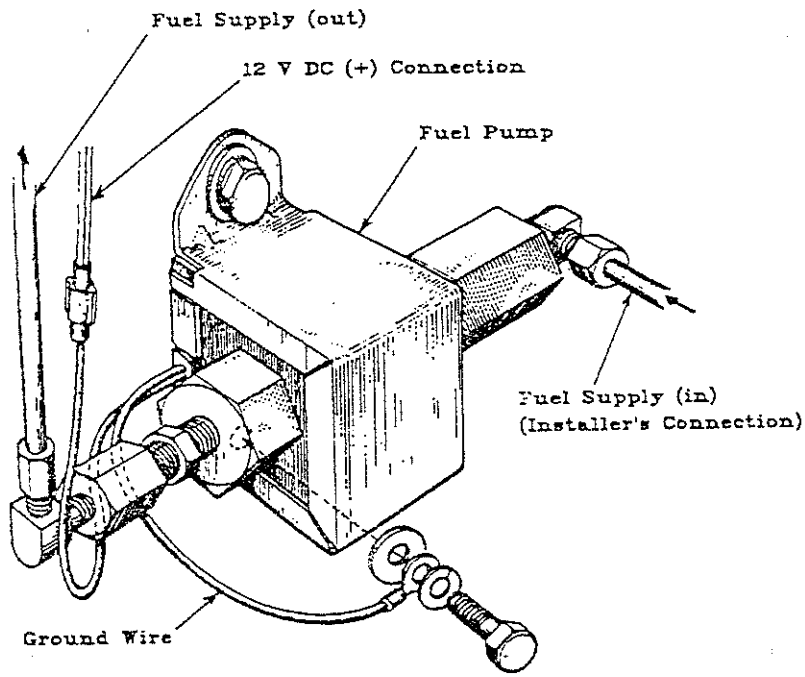
Fuel Pump

The engine mounted fuel pump requires little or no maintenance. Ensure fuel being supplied to this pump is free of water or other types of contaminants that will hinder the pump's operation.

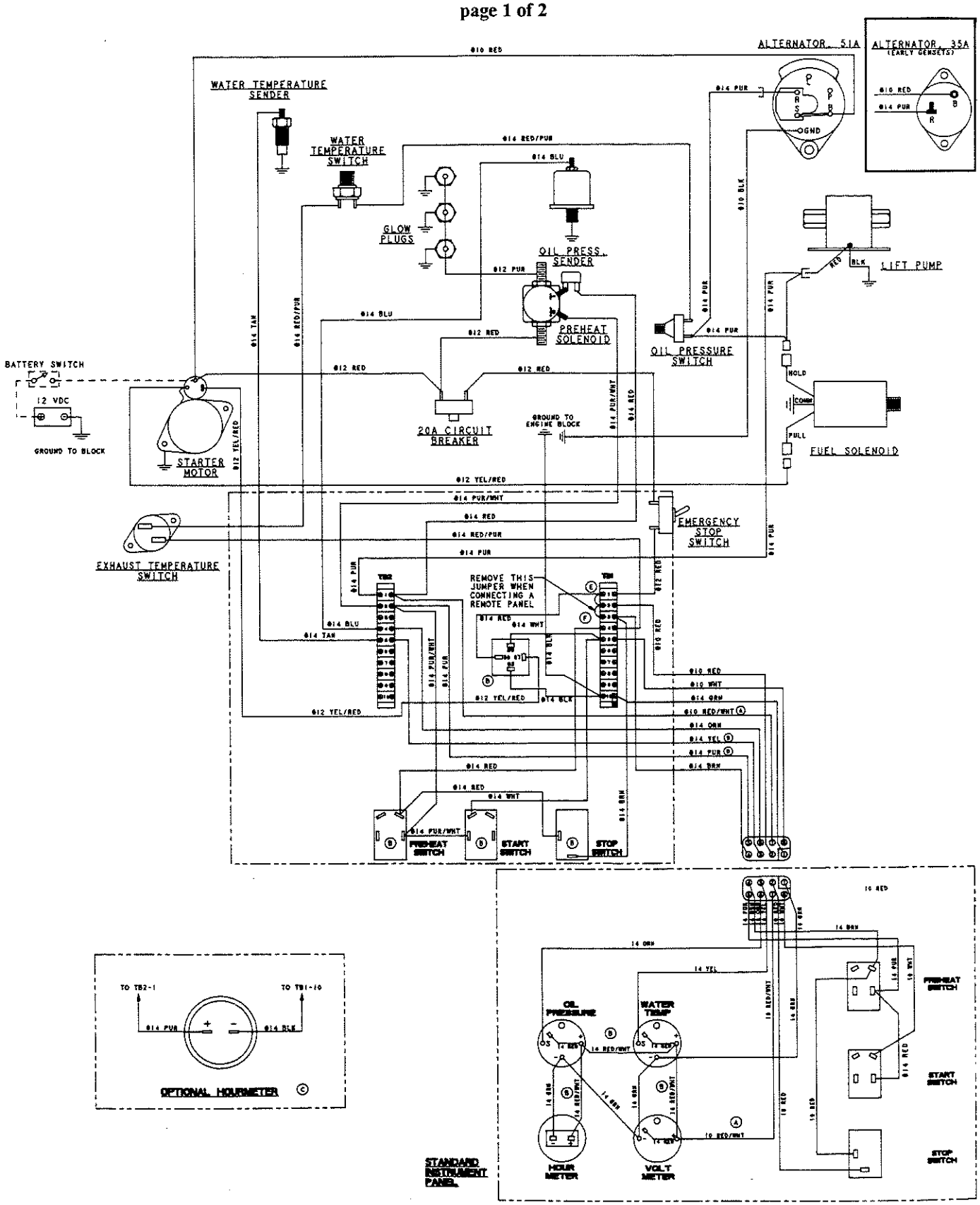
Periodically check the fuel connections to and out of the pump and make sure that no leakage is present and that the fittings are tight and secure. The DC ground connection at one of the pumps mounting bolts should be clean and well secured by the mounting bolt to ensure proper pump operation.

WARNING

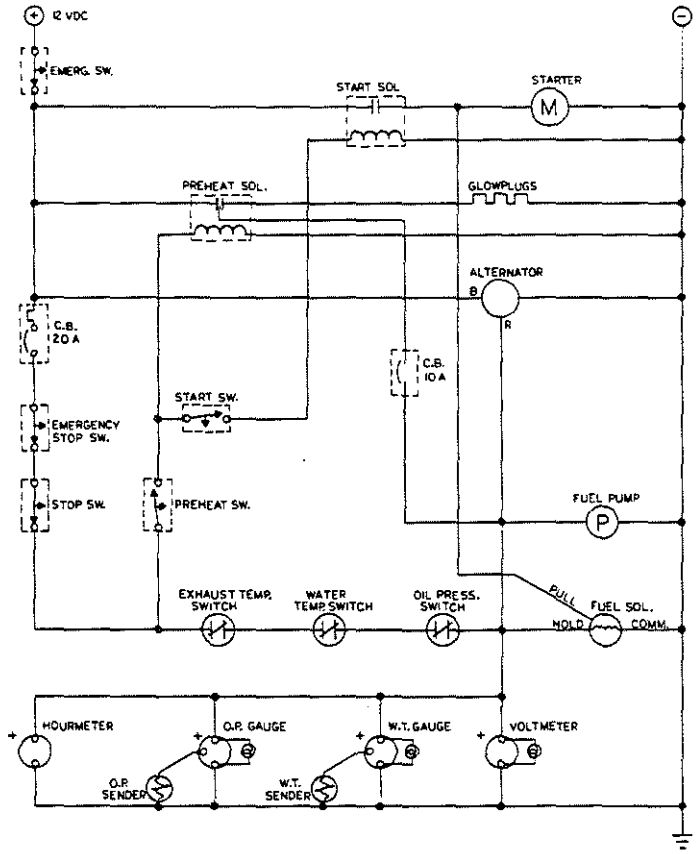
Fuel leakage at the fuel pump or its connections is a fire hazard and should be corrected. Make sure proper ventilation exists whenever servicing fuel system components.



7.6 BTD Control Circuit Wiring Diagram #039284
page 1 of 2



7.6 MINI BTD
Schematic Diagram #39284
page 2 of 2



STARTING AND STOPPING INSTRUCTIONS

START : 1. ALWAYS PUSH PREHEAT SWITCH FIRST. HOLD FOR 15 TO 60 SECONDS AS REQUIRED.

2. WHILE CONTINUING TO PUSH PREHEAT SWITCH, PUSH START SWITCH.

3. WHEN GENERATOR STARTS, RELEASE START SWITCH ONLY.

4 WHEN OIL PRESSURE REACHES APPROXIMATELY 20 PSI, RELEASE PREHEAT SWITCH. (THE PREHEAT SWITCH OVERRIDES THE LOW OIL PRESSURE SHUT DOWN CIRCUIT).

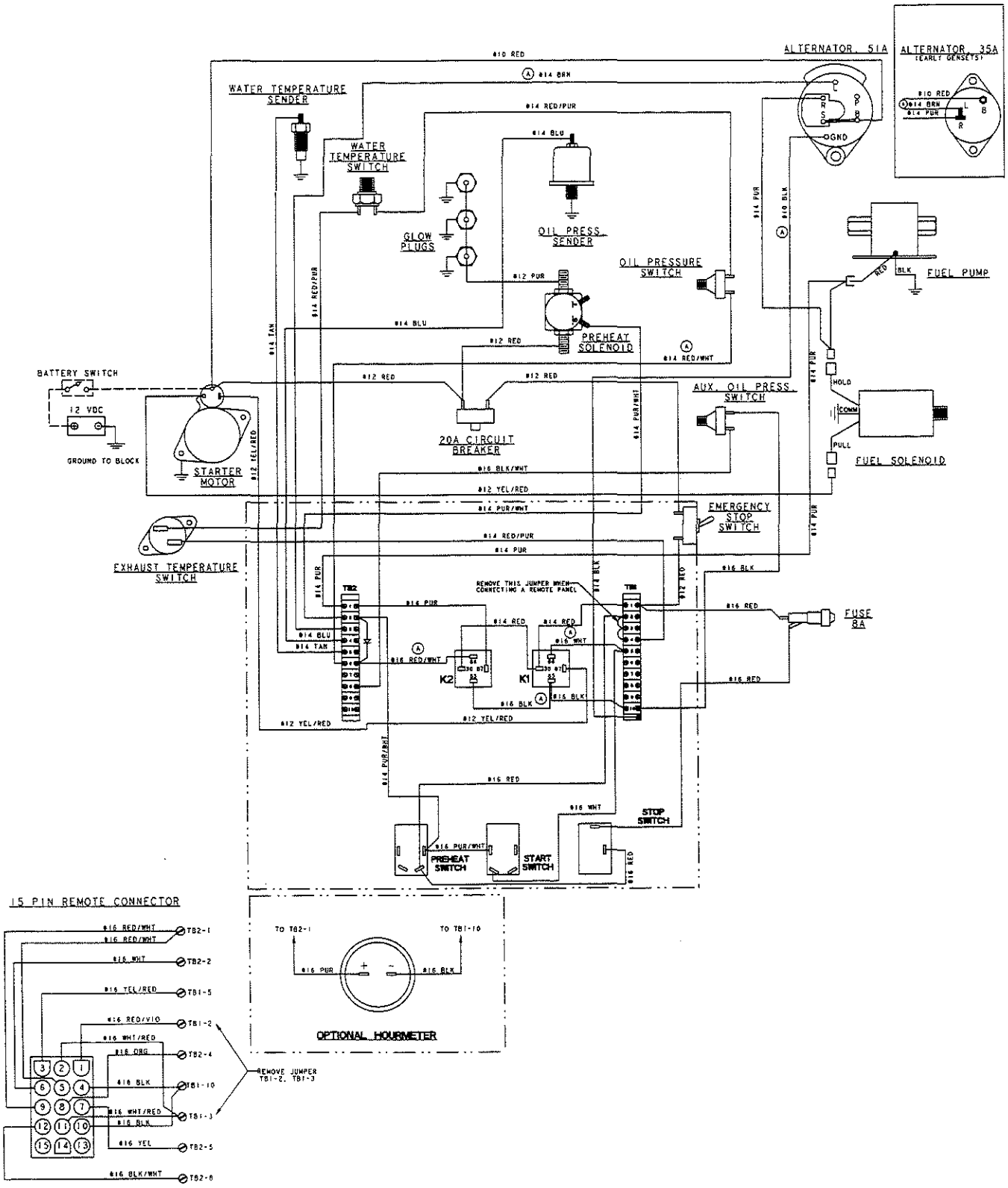
STOP: 1. PUSH AND HOLD THE STOP SWITCH UNTIL GENERATOR STOPS COMPLETELY.

NOTES:

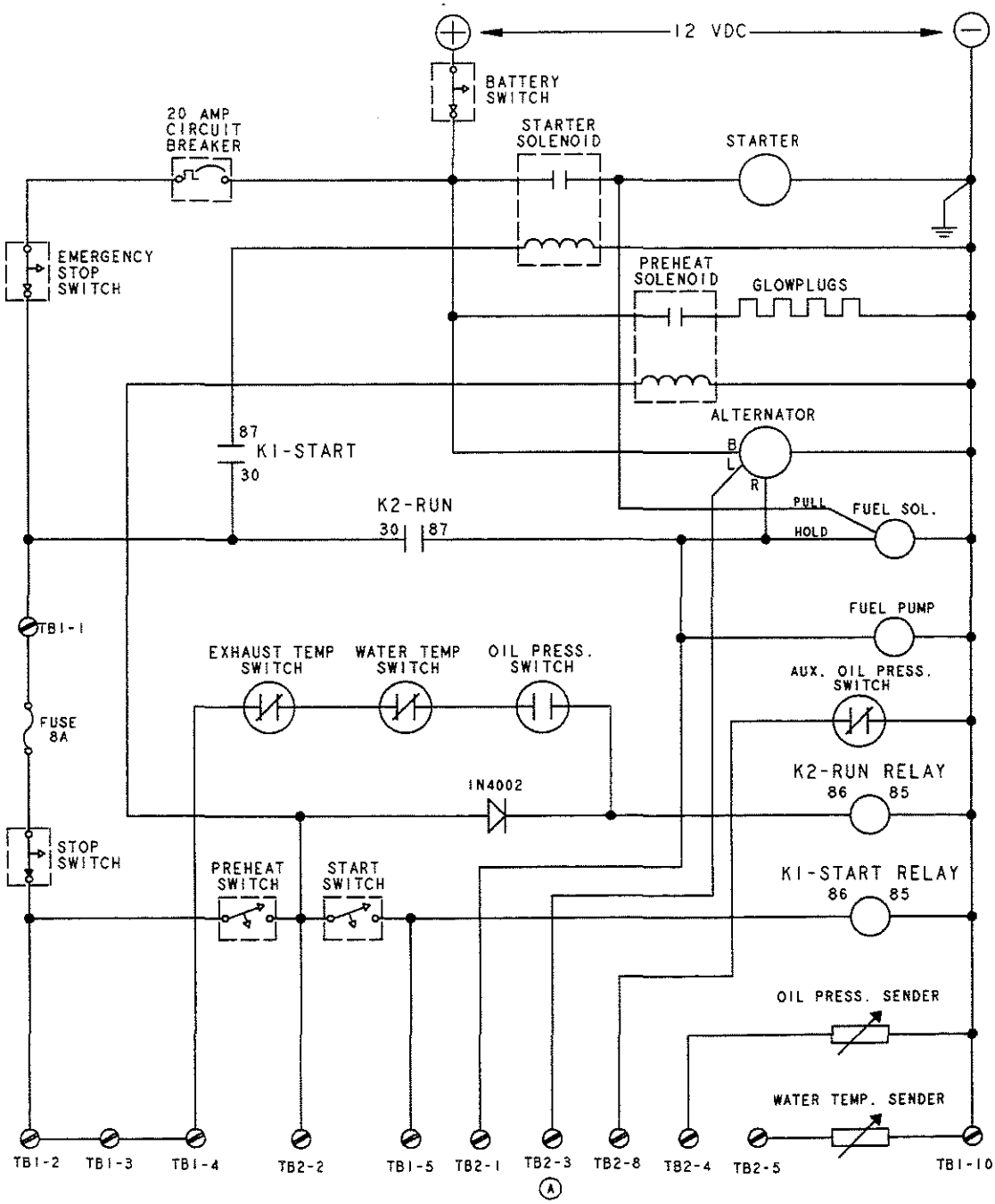
1. THIS PRODUCT IS PROTECTED BY A MANUAL RESET CIRCUIT BREAKER LOCATED NEAR THE STARTER AND AS CLOSE TO THE CURRENT SOURCE AS POSSIBLE EXCESSIVE CURRENT DRAW ANYWHERE IN THE INSTRUMENT PANEL, WIRING, OR ENGINE WILL CAUSE THE BREAKER TO TRIP. IN THIS EVENT MOST GENERATORS WILL SHUT DOWN BECAUSE THE OPENED BREAKER DISCONNECTS THE FUEL SUPPLY. THEREFORE THE OWNER/BUILDER MUST BE SURE THAT THE INSTRUMENT PANEL, WIRING, AND ENGINE ARE INSTALLED TO PREVENT CONTACT BETWEEN ELECTRICAL DEVICES AND SALT WATER.

2. AN ON-OFF SWITCH SHOULD BE INSTALLED IN THIS CIRCUIT TO DISCONNECT THE STARTER FROM THE BATTERY IN AN EMERGENCY AND WHEN LEAVING THE BOAT. TWELVE VOLT DIESEL ENGINE STARTERS TYPICALLY DRAW 200 TO 300 AMPS WHEN CRANKING. THE DURATION OF INDIVIDUAL CRANKING CYCLES SHOULD NOT EXCEED 30 SECONDS. A SWITCH WITH A CONTINUOUS RATING OF 175 AMPS AT 12 VDC WILL NORMALLY SERVE THIS FUNCTION, BUT A SWITCH MUST NEVER BE USED TO "MAKE" THE STARTER CIRCUIT.

7.6 BTD Control Circuit DC Wiring Diagram #044121
(Two Relays)



7.6 BTD DC Schematic Diagram #044121
(Two Relays)



COOLING SYSTEM

Description

Westerbeke marine diesel generators are designed and equipped for fresh water cooling. Heat produced in the engine by combustion and friction is transferred to fresh water which circulates throughout the engine. This circulating fresh water cools the engine block and its internal moving parts. The heat is transferred externally from the fresh water to raw water by means of a heat exchanger; similar in function to an automotive radiator. Raw water flows through the tubes of the heat exchanger while fresh water flows around the tubes; engine heat transferred to the fresh water is conducted through the tube walls to the raw water which is then pumped into the exhaust system where finally it is discharged overboard. In other words, the engine is cooled by fresh water, the fresh water is cooled by raw water, and the raw water carries the transferred heat over the side through the exhaust system. The fresh water and raw water circuits are independent of each other. Using only fresh water within the engine allows the cooling water passages to stay clean and free from harmful deposits. The two independent circuits and their components are discussed in the following paragraphs.

Fresh Water Circuit

> NOTE: Refer to paragraphs A and B in this section for the recommended antifreeze and water mixture to be used as the fresh water coolant and for information on filling the fresh water system.

Fresh water is pumped through the engine by a belt-driven circulating pump, absorbing heat from the engine. The fresh water coolant circulates through the engine's block absorbing heat, then passes through the thermostat into the exhaust manifold, to the heat exchanger where it is cooled, and then is returned to the engine block through the suction side of the fresh water circulating pump. When the engine is started cold, external fresh water flow is prevented by the closed thermostat (although some fresh water flow is bypassed around the thermostat to prevent the exhaust manifold from overheating). As the engine warms up, the thermostat gradually opens, allowing full flow of the engine's fresh water coolant to flow unrestricted to the external portion of the cooling system.

A. Fresh Water Coolant (Antifreeze) Mixture.

A freshwater and antifreeze mixture should be used year-round in the cooling system. Water, when it freezes, expands sufficiently to split the heat exchanger and crack the engine block. A water/antifreeze mixture of proper concentration will prevent freezing (see the antifreeze/water mixture chart).

Use soft water with few impurities, such as tap water (potable water) or rainwater. **Never** use hard or foul water. Use of hard water or water containing impurities will lead to the collection of scale in the engine and heat exchanger which will reduce the cooling system's efficiency.

Antifreeze of poor quality or without rust inhibitors will cause corrosion within the cooling system. Always use antifreeze which is compatible with aluminum cooling system components and is made by a reliable manufacturer. **Never** mix different brands of antifreeze. Make sure that the cooling system of the engine is well cleaned before adding antifreeze. Recommended antifreeze for year round use is ZEREX or PRESTONE with rust inhibitors.

In order to control the concentration of the mixture, mix the antifreeze and freshwater thoroughly before adding it to the cooling system.

ANTIFREEZE CONCENTRATION DATA

Antifreeze Concentration	%	13	23	30	35	45	50	60
Freezing Temperature	° F	23	14	5	-4	-22	-40	-58
	(° C)	(-5)	(-10)	(-15)	(-20)	(-30)	(-40)	(-50)

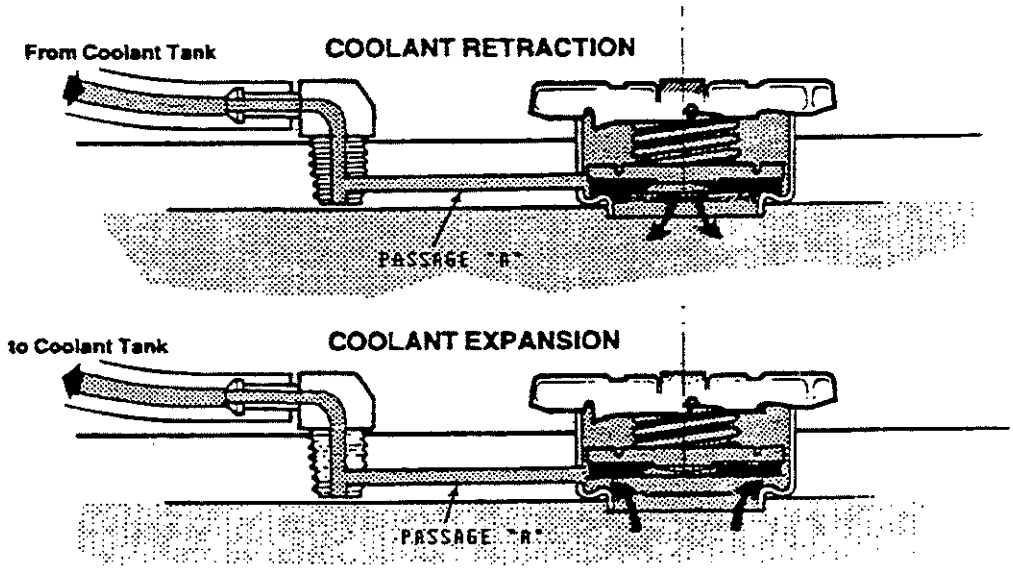
B. Filling the Fresh Water System

A coolant recovery tank kit is supplied with each Westerbeke diesel engine. The purpose of this recovery tank is to allow for engine coolant expansion and contraction, during engine operation, without the loss of coolant and without introducing air into the cooling system.

This coolant recovery tank kit is supplied with each Westerbeke diesel engine. The purpose of this recovery tank is to allow for engine coolant expansion and contraction, during engine operation, without the loss of coolant and without introducing air into the cooling system.

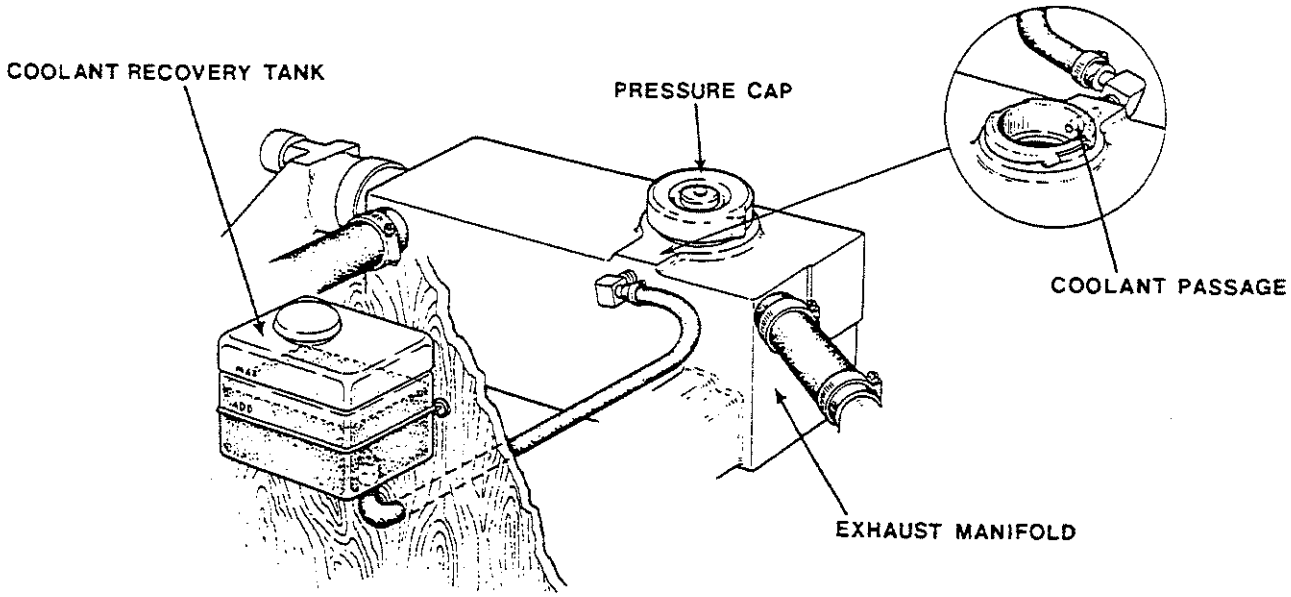
This coolant recovery tank should be installed at, or above, engine manifold level, in a location where it can be easily monitored and where coolant can be easily added if needed (see the figure below). A stainless steel mounting bracket is supplied with each kit along with a 30 inch length of clear plastic hose and clamps to connect the hose between the engine's manifold fitting to the hose spud on the base of the recovery tank.

FUNCTION OF MANIFOLD PRESSURE CAP



Coolant from the engine, when heated during engine operation, will expand, lifting the spring-loaded manifold pressure cap, and enter the recovery tank by way of the hose connecting the recovery tank to the manifold.

When the engine is shut down and cools, a small check valve in the pressure cap is opened by the contraction of the engine coolant, allowing some of the coolant in the recovery tank to be drawn back into the engine's cooling system, free of air without loss. Periodically check that the passage (A) between the 90° fitting on the manifold and the filler neck in the manifold is clear so coolant flow in either direction.



Coolant Recovery Tank, Recommended Installation

Fill the fresh water system as follows:

1. Remove the pressure cap from the manifold.

2. Pour a clean, antifreeze mixture into the manifold and allow enough time for the coolant to fill the fresh water cooling system.

3. Start the engine and allow it to come up to its operating temperature. Monitor the coolant in the manifold and add antifreeze coolant as air is expelled. Once all air is expelled from the system, fill the manifold to the filler neck and install the pressure cap. Open the air bleed petcocks, each in turn, located on the upper inboard side of the manifold to allow any air in that area of the manifold to escape. Close the petcock securely.

4. Remove the plastic cap from the plastic coolant recovery tank and fill the tank with coolant halfway between the ADD mark and the MAX mark. Replace the plastic cap.

5. Run the engine and observe the coolant's expansion flow into the plastic recovery tank.

6. Check for leaks between the pressure cap/filler neck and the plastic recovery tank. Stop the engine and allow it to cool. Coolant should be drawn back into the cooling system as the engine's temperature comes down. Check the coolant passage in the filler neck to ensure it is open to flow. Clean it with a heavy piece of wire periodically to ensure it remains open. Once a season or more should you find it necessary.

7. Add coolant to the recovery tank, as required, to top off the fresh water coolant system and periodically check to see that the manifold is full of coolant by removing the pressure cap **when the engine is cold.**

Thermostat

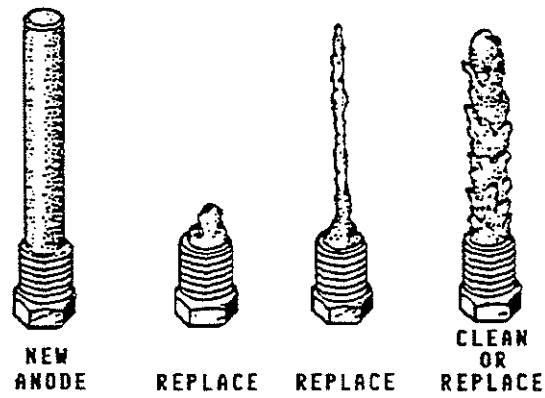
Generally, thermostats are of two types. One is simply a choking device which opens and closes as the engine's temperature rises and falls. The second type has a bypass mechanism. Usually, this is a disc on the bottom of the thermostat which moves downward to close off an internal bypass passage within the head. Since 1980, each type of thermostat has a hole punched through it. The hole is a bypass to prevent the exhaust manifold from overheating during the engine's warm-up. Replacement thermostats *must* have this design characteristic.

Raw Water Circuit

The raw water flow is created by a gear-driven, positive displacement, neoprene impeller pump. The pump draws raw water directly from the ocean through the sea cock and raw water strainer and passes the water to the heat exchanger's raw water inlet. The raw water passes through the heat exchanger's tubes, from which heat from the fresh water system that circulates around these tubes is absorbed, and then the raw water is discharged from the cooling system overboard through the water-injected wet exhaust system. Be sure to clean zinc debris from the area inside of the heat exchanger where the zinc anode is positioned as this debris lays in front of these tube ends and blocks them.

Zinc Anode

A zinc anode, or pencil, is located in the raw water cooling circuit within the heat exchanger. The purpose of the zinc anode is to sacrifice itself to electrolysis action taking place in the raw water cooling circuit, thereby reducing the effects of electrolysis on other components of the system. The condition of the zinc anode should be checked monthly and the anode cleaned or replaced as required. Spare anodes should be carried on board.

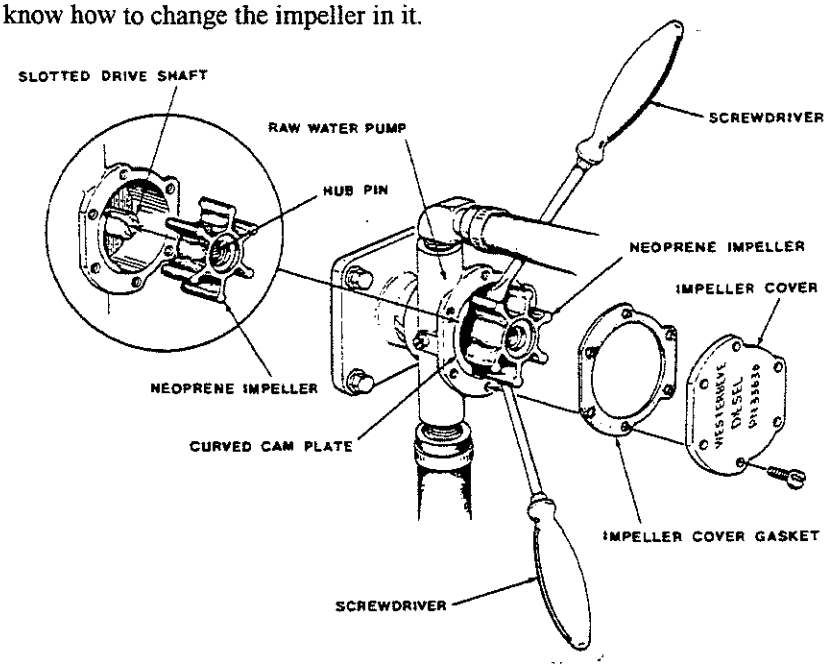


NOTE: Electrolysis action is the result of each particular installation and vessel location; not that of the generator.

If the zinc pencil needs replacement, **hold the hex boss into which the zinc pencil is threaded with a wrench while loosening the anode with another wrench.** This prevents the hex boss from possibly tearing off the exchanger shell. After removing the zinc, note the condition of it. If the zinc is in poor condition, there are probably a lot of zinc flakes within the exchanger. Remove the end of the heat exchanger and clean the inside of all zinc debris. **Always have a spare heat exchanger end gasket in case the present one becomes damaged when removing the end cover.** Replace the gasket (refer to your engine model's heat exchanger end gasket part number), cover, and install a new zinc pencil.

Raw Water Pump

The raw water pump is a self-bleeding, gear-driven, rotary pump with a non-ferrous housing and a neoprene impeller. The impeller has flexible vanes which wipe against a curved cam plate within the impeller housing, producing the pumping action. **On no account should this pump be run dry.** There should always be a spare impeller and impeller cover gasket aboard (an impeller kit). Impeller failures occur when lubricant (raw water) is not present. Such failures are not warrantable and the operator's are cautioned to make sure raw water flow is present at start-up. Know your pump, know its location on the engine and know how to change the impeller in it.



Remove the impeller with the aid of two small screwdrivers, as illustrated, and carefully pry the impeller out of the pump. Install the impeller by positioning the hub pin to align with the slot in the drive shaft. Move the blades to conform to the curved cam plate and push the impeller into the pump's housing.

Water Pump Drive Belt Tension

Generator models come equipped with belt guards that cover over the belt(s) on the front of the engine. ("Out of sight-out of mind." The belt guard is not installed for that purpose.) Operators are advised that the inspection, service, and maintenance spoken of below should be followed.

WARNING

Never attempt to adjust the drive belt's tension while the engine is in operation.

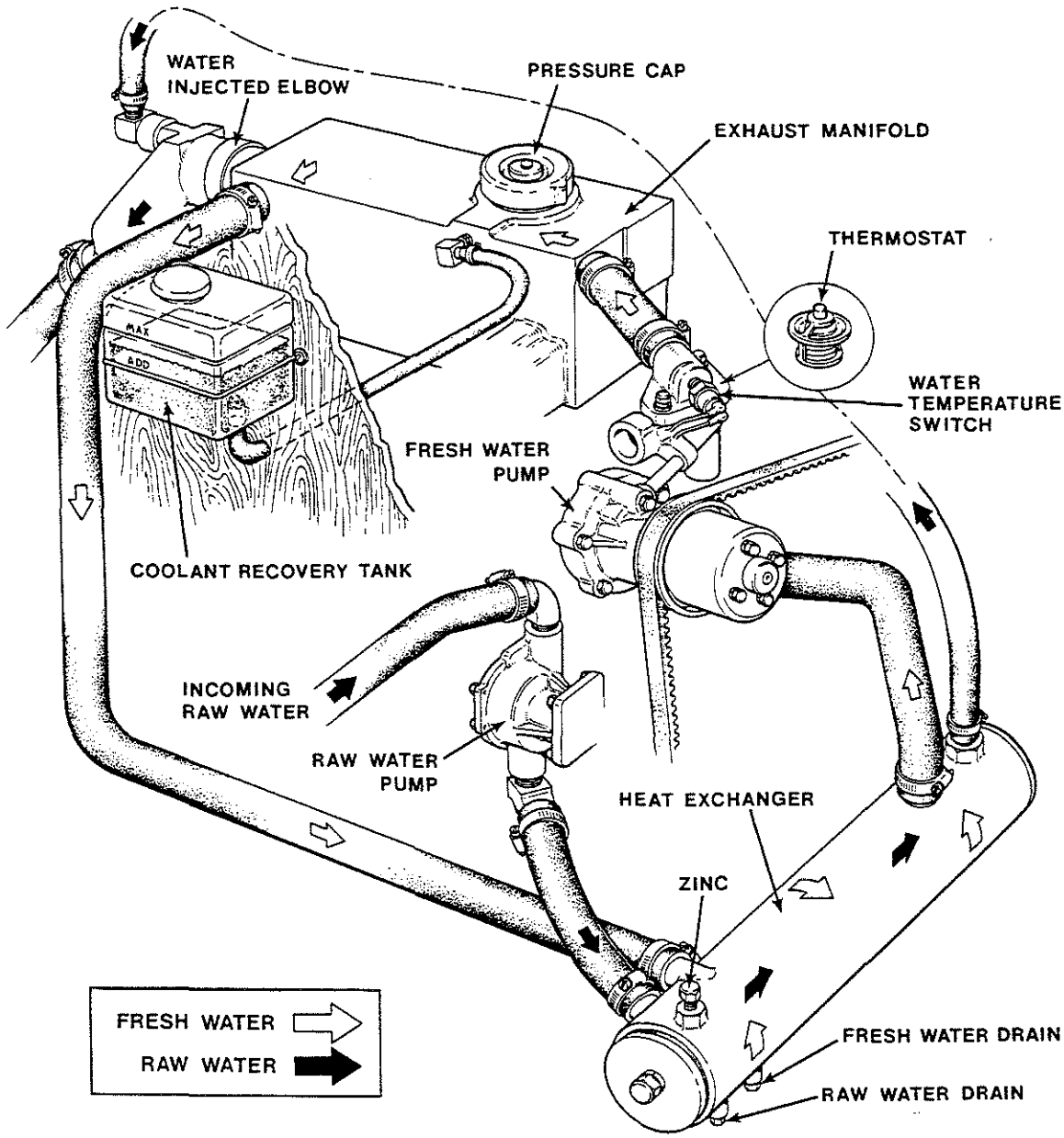
CAUTION

Excessive water pump drive belt tension can cause rapid wear of the belt and reduce the service life of the fresh water pump's bearings. Excessive slack or the presence of oil on the belt can cause belt slipping, resulting in high operating temperatures.

The water pump drive belt is properly adjusted if the belt can be deflected no less than 3/8 inch and no more than 1/2 inch (10mm, 12mm) as the belt is depressed with the thumb at the midpoint between the two pulleys on the longest span of the belt. A spare drive belt should be carried on board.

Cooling System

Illustrated below is a typical Westerbeke engine cooling system. Both fresh water and raw water flow through their independent cooling circuits. Refer to your generator's Parts List for part numbers and part descriptions if you need to order cooling system parts for your engine.



LUBRICATION SYSTEM

Engine Oil

For engine lubrication, use lubricating oil designated for diesel service. These oils are classified according to the API specifications into service grades CA, CB, CC and CD. The use of CC or higher (CD) grades, made by well-known manufacturers is recommended.

Engine Oil Viscosity (SAE Number)

Use an oil having a viscosity best suited to the atmospheric temperature. Use of an all-season oil SAE 10W-30 with minimum viscosity change under different temperatures is suggested.

Atmospheric Temperature	Viscosity
68° F (20° C) or higher	SAE 30 or 10W-30
41° F (5° C) - 68° F (20° C)	SAE 20 or 10W-30
41° F (5° C) - or lower	SAE 10W-30

NOTE: Do not use an engine lubricating oil with an SAE number greater than 30 in the engine.

Oil Pressure

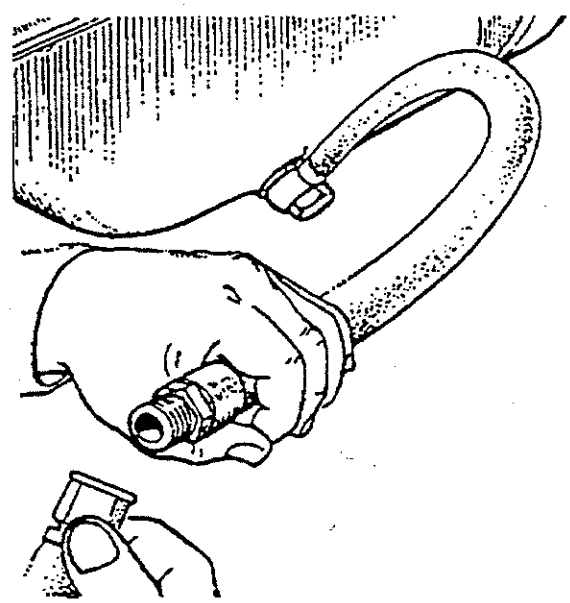
The engine's oil pressure, during operation, is indicated by the oil pressure gauge on the instrument panel. During normal operation, the oil pressure will range between 35 and 55 psi.

NOTE: A newly started, cold engine can have an oil pressure reading upwards of 60 psi. A warmed engine can have an oil pressure reading as low as 35 psi. These readings will vary depending upon the temperature of the engine and the load placed on the generator.

Engine Oil Change (to include filter)

1. Draining the Oil Sump

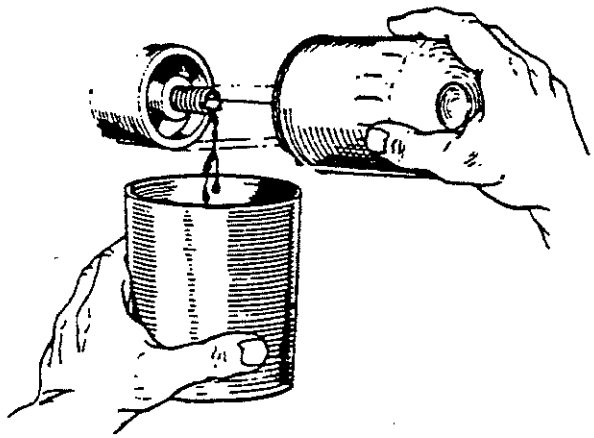
Discharge the old oil through the sump drain hose (attached to the front of the engine) while the engine is still warm. Drain the oil oil completely, replace the hose in its bracket, and replace the end cap securely.



Always observe the oil as it is removed. A yellow/gray emulsion indicates the presence of water in the oil. Although this condition is rare, it does require prompt attention to prevent serious damage. Call a competent mechanic should water be present in the oil. Raw water present in the oil can be the result of a fault in the exhaust system attached to the engine and/or siphoning through the raw water cooling circuit into the exhaust, filling it up to the engine.

2. Replacement of the Oil Filter

When removing the used oil filter, you may find it helpful and cleaner to punch a hole in the upper and lower portion of the old filter to drain the oil from it into a container before removing it. This helps to lessen spillage. A small style automotive filter wrench should be helpful in removing the old oil filter. Place some paper towels and a plastic bag around the filter when unscrewing it to catch any oil left in the filter. (Oil or any other fluid on the engine reduces the engine's cooling ability. Please keep your engine clean.) Inspect the old oil filter as it is removed to make sure that the rubber sealing gasket came off with the old oil filter. If this rubber sealing gasket remains sealed against the engine block, gently remove it. The replaceable cartridge-type oil filter requires no cleaning inside, so it may be properly disposed of properly.

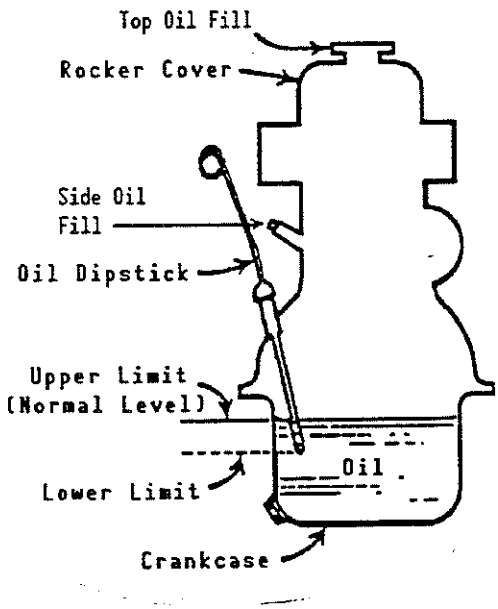


When installing the new oil filter element, wipe the filter gasket's sealing surface on the engine block free of oil and apply a thin coat of clean engine oil to the rubber gasket on the new oil filter. Screw the filter onto the threaded oil filter stub, and then tighten the filter firmly by hand.

> NOTE: Generic filters are not recommended, as the material standards or diameters of important items on generic parts might be entirely different from genuine parts. Immediately after an oil filter change and oil fill, run the engine to make sure the oil pressure is normal and that there are no oil leaks around the new oil filter.

3. Filling the Oil Sump

Add the new oil through the oil filler cap on the top or side of the engine. After refilling the oil, run the generator for a few moments while checking the engine's oil pressure. Make sure there is no leakage around the new oil filter or from the oil drain system, and stop the generator. Then check the quantity of oil with the lube oil dipstick. Fill to, but not over, the high mark on the dipstick, should the engine require additional oil.



BT GENERATOR

This generator is a brushless self-excited generator, which requires only the driving force of the engine to produce AC output. The copper and laminated iron in the exciter stator are responsible for the self-exciting feature of this generator. The magnetic field produced causes an AC voltage to be induced into the related exciter rotor windings during rotation. Diodes located in the exciter rotor rectify this voltage to DC and supply it to the windings of the rotating field. This creates an electromagnetic field which rotates through the windings of the main stator, inducing an AC voltage which is supplied to a load. A transformer is connected in parallel to the AC output of the main stator. An AC voltage is produced in the auxiliary windings of the transformer and main stator and is, in turn, supplied to a full-wave bridge rectifier. The rectifier produces a DC voltage to further excite the excitor stator windings, enabling the generator to produce a rated AC output.

No-Load Voltage Adjustment

Voltage adjustment is made with the compound transformer governing generator regulation.

1. Operate the generator and apply a moderate load momentarily; then remove the load. Note the voltage output from the generator's 120-Volt leg(s) (110 Volts at 50 Hertz). The no-load voltage should be between 121 - 123 Volts at 61.5 - 62 Hertz (111 - 113 Volts at 51.5 - 52 Hertz).

> NOTE: The no-load voltage should be adjusted to the voltage produced by the generator when: the generator is started, a momentary load is applied to excite the transformer, and then removed. The voltage produced by the generator after this momentary load is removed is the no-load voltage.

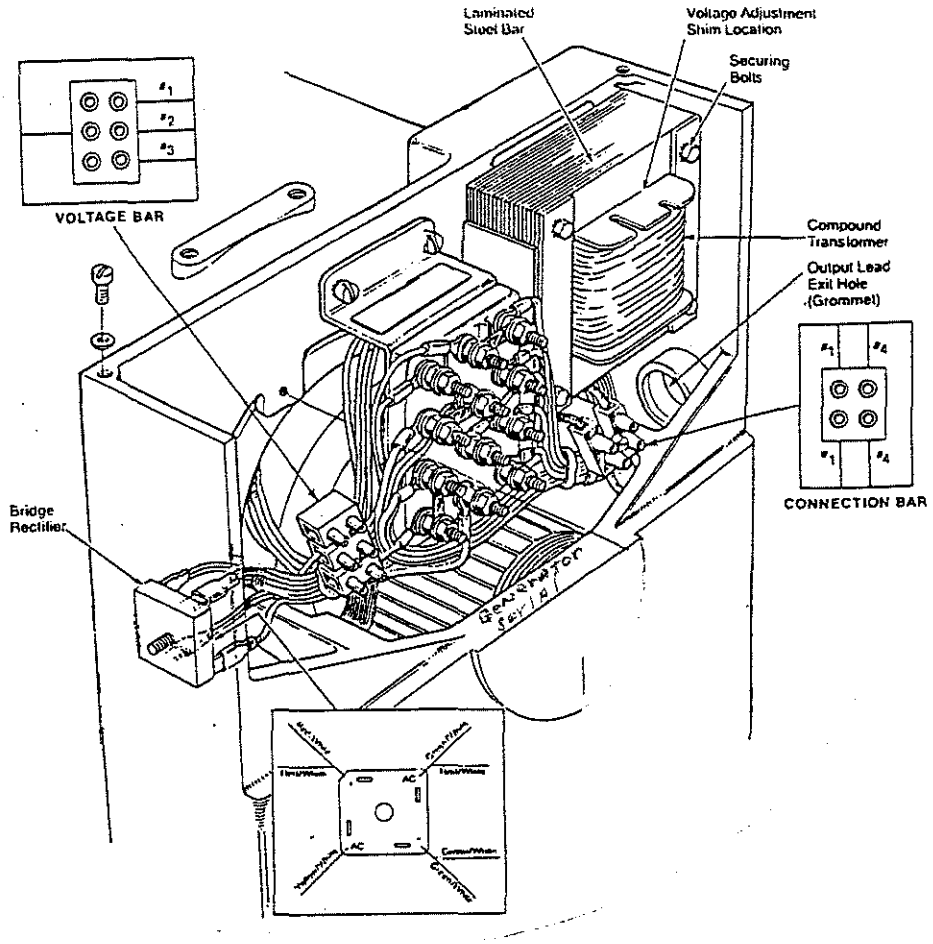
2. To raise or lower the voltage, non-conductive shims of varying thickness are inserted or removed from under the laminated steel bar that is situated on top of the compound transformer. The material used for shimming should not soften at temperatures in the 176° F (80° C) range. A small reduction in no-load voltage (1 to 3 volts) sometimes can be accomplished by gently tapping the top of the laminated steel bar to reduce the air gap between the existing shims and the transformer core.

CAUTION

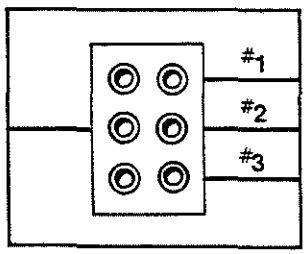
> Under no circumstances attempt to increase the no-load voltage by increasing the gap between the laminated steel bar and the transformer core without the use of shims. Magnetic forces created within the transformer during the generator's operation may close the air gap and reduce the no-load voltage output.

3. To remove the laminated steel bar, remove the two upper securing bolts from the compound transformer and lift the bar from the transformer. The addition of shim thickness will raise the no-load voltage and, conversely, the removal of shim thickness will lower the no-load voltage.

Varying shim thickness by .001 inch (0.025 mm) will change the no-load voltage by 4 to 6 volts.



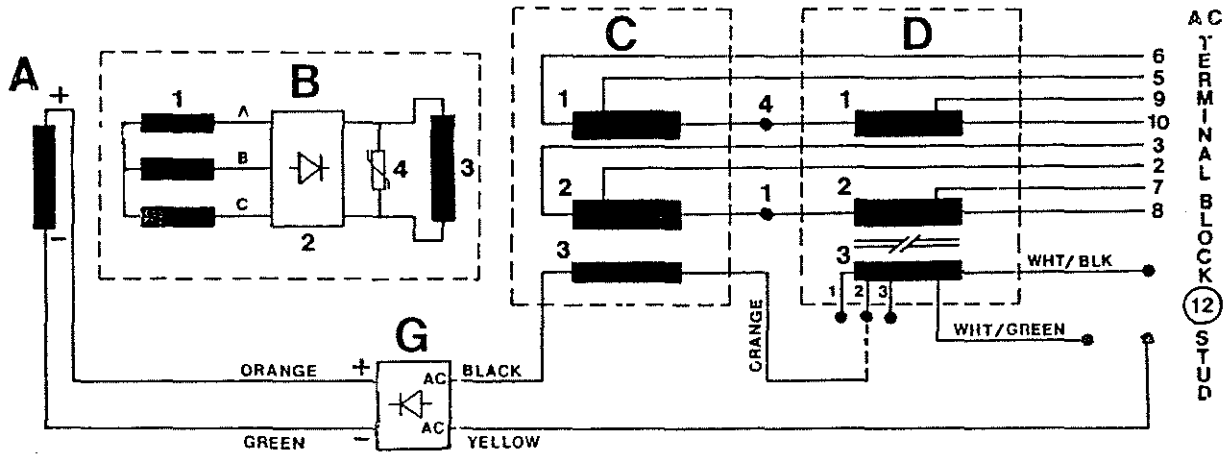
7.6 BTD - View of Generator Backend



VOLTAGE BAR

VOLTAGE BAR

The voltage bar has three leads coming in on one side from the transformer and a single lead on the other routed to the bridge rectifier. The single lead can be positioned at either of the three connections. These connections are used to change the output voltage of the generator under load. Should the voltage go below minimum. Reposition this connection to increase output voltage under load.



BTD 7.6 KW Generator's Internal Wiring Diagram

A. EXCITER STATOR WINDINGS
   1. Exciter Stator Windings

B. EXCITER ROTOR
   1. Auxiliary Windings (a-b-c)
   2. Diodes (6)
   3. Rotating Field Windings
   4. Pozi Resistor

C. MAIN STATOR
   1. Main Stator Windings
   2. Main Stator Windings
   3. Main Stator Auxiliary Windings

D. COMPOUND TRANSFORMER
   1. Compound Transformer Windings
   2. Compound Transformer Windings
   3. Compound Transformer Auxiliary Windings

E. BRIDGE RECTIFIER

Generator Frequency

Frequency is a direct result of engine/generator speed:

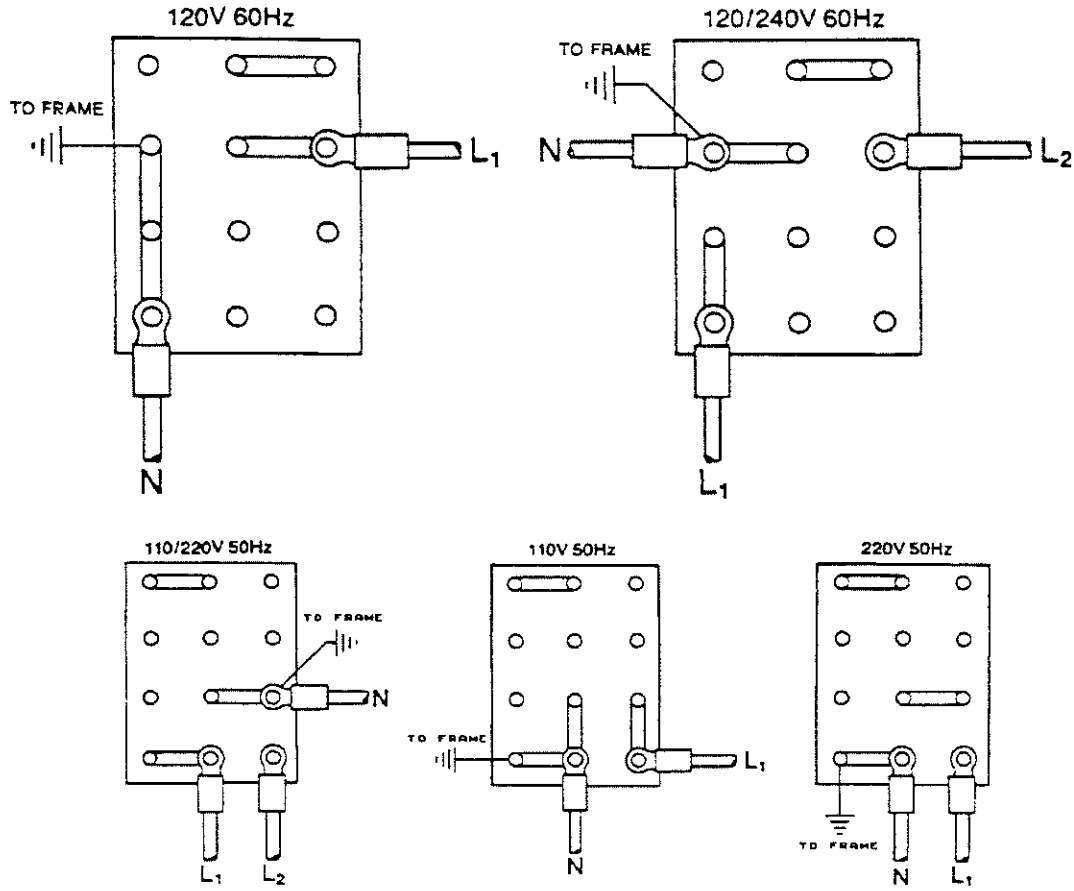
1800 RPM - 60 Hertz
1500 RPM - 50 Hertz

To change the generator's frequency, refer to the "MAINTENANCE AND ADJUSTMENTS" section of this manual.

Load Connections

The generator's data plate gives the voltage, current and frequency rating of the generator. An AC wiring decal is affixed to the inside of the louvered cover on the generator end. A diagram of the various AC voltage connections is provided on the decal. The information on the decal is similar to the figure shown on the following page.

The generator is a single-phase, reconnectable 120 volts AC two-wire or 120/240 volts AC three-wire, at 60 Hertz; or 110 volts AC two-wire, 110/220 volts AC three-wire, or 220 volts AC two-wire, at 50 Hertz. Refer to the "SYSTEM SPECIFICATIONS" section of this manual for ratings, located at the beginning of this manual.



AC Voltage Connections (12 Stud Terminal Block)

NOTE: The frame ground wire must be moved when changing from 110 volts, 50 Hertz to 220 volts, 50 Hertz.

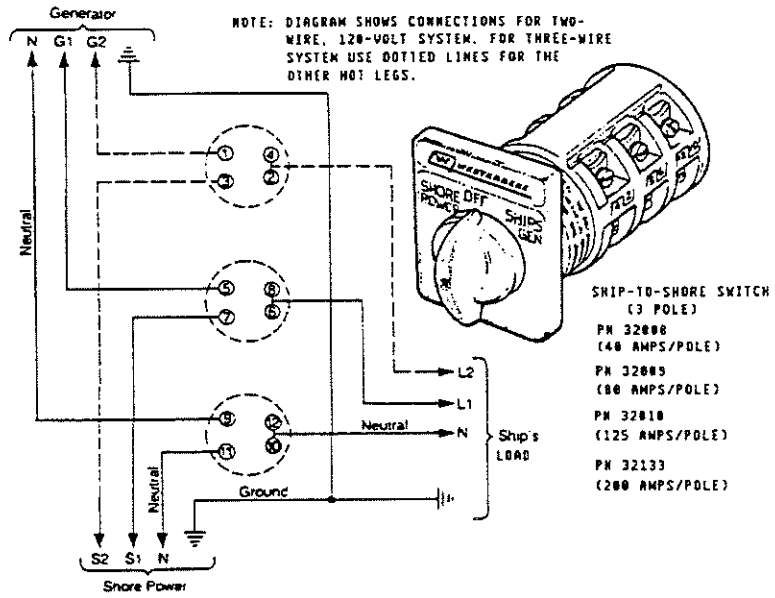
For making connections to the AC terminal block, use terminal ends for #10 studs which will accept #6 or #8 multi-strand wire.

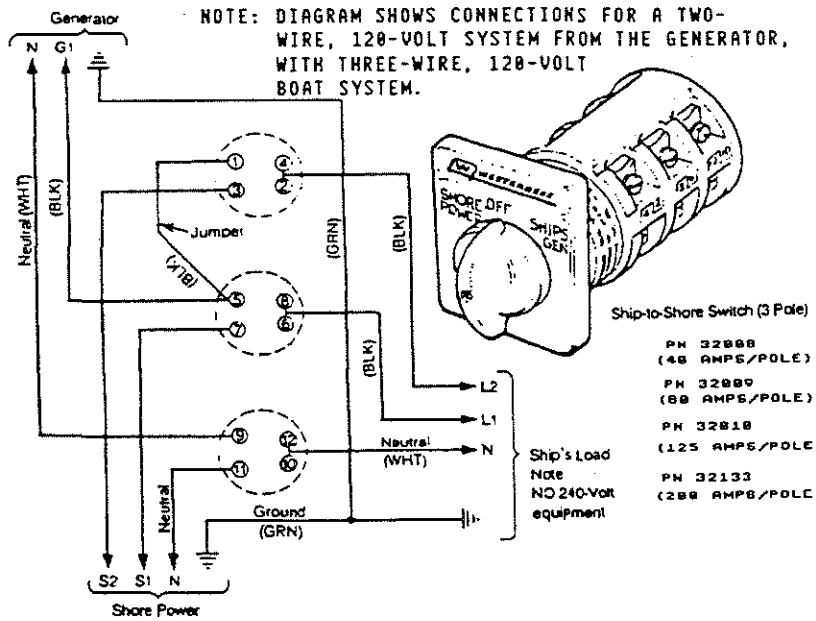
Shore Power Connections

If the installer connects shore power to the vessel's AC circuit, this must be done by means of the SHORE POWER/OFF/SHIPS GEN, center position-off transfer switch as shown below. Use of this switch prevents simultaneous connection of shore power to generator output.

CAUTION

Damage to the generator can result if utility shore power and generator output are connected at the same time. This type of generator damage is not covered under the warranty; it is the installer's responsibility to ensure that all AC connections are correct.





Shore Power Switch Connection Diagrams

Use of Electric Motors

The power required to start an electric motor is considerably more than is required to keep it running after it is started. Some motors require much more current to start than others. Split-phase (AC) motors require more current to start, under certain circumstances, than other types. They are commonly used on easy-starting loads, such as washing machines, or where loads are applied after the motor is started, such as small power tools. Because they require 5 to 7 times as much current to start as to run, their use should be avoided, whenever possible, if the electric motor is to be driven by a small generator. Capacitor and repulsion-induction motors require from 2 to 4 times as much current to start as to run. The current required to start any motor varies with the load connected to it. An electric motor connected to an air compressor, for example, will require more current than a motor to which no load is connected.

In general, the current required to start 115-Volt motors connected to medium starting loads will be approximately as follows:

MOTOR SIZE (HP)	AMPS FOR RUNNING (Amperes)	AMPS FOR STARTING (Amperes)
1/6	3.2	6.4 to 22.4*
1/4	4.6	9.2 to 32.2*
1/3	5.2	10.4 to 72.8*
1/2	7.2	14.4 to 29.2
3/4	10.2	20.4 to 40.8
1	13	26 to 52

*NOTE: In the above table the maximum "Amps for Starting" is more for some small motors than for larger ones. The reason for this is that the hardest starting types (split-phase) are no made in larger sizes.

Because the heavy surge of current needed for starting motors is required for only an instant, the generator will not be damaged if it can bring the motor up to speed in a few seconds. If difficulty is experienced in starting motors, turn off all other electrical loads and, if possible, reduce the load on the electric motor.

Required Operating Speed

Although individual units may vary slightly, the normal voltage and frequency of typical 60-(50-)Hertz engine-driven generators described in this manual are approximately as follows: run first with no load applied, then at half the generator's capacity, and finally loaded to its full capacity as indicated on the generator's data plate.

See the rpm/Hertz/frequency chart on the next page.

Load Applied	4-Pole Speed (rpm)	Frequency (Hertz)	Generator 120V (110) Plants	Voltage 240V (220) Plants
None	1830 (1530)	62 (52)	122 (112)	240 (224)
Half	1800 (1500)	60 (50)	120 (110)	240 (220)
Full	1755 (1455)	59 (49)	110 (100)	220 (200)

The output voltage should be checked periodically to ensure proper operation of the generating plant and the appliances it supplies.

If an AC voltmeter or ampmeter is not installed to monitor voltage and load, check it with a portable meter and amp-probe.

Preventive Maintenance (Generator)

Maintenance on the generator is minimal.

1. Keep the generator **clean, dry and well-ventilated.**

2. Ensure that all connections are clean and tight and that cables carrying AC voltage are properly supported and protected against chafing.

3. The rear armature bearing is lubricated and sealed; therefore, no maintenance is required. If the bearing becomes rough or noisy, replace it.

Generator Troubleshooting

A complete and illustrated test on troubleshooting the BTD series of generators is furnished in the Technical Manual which is available through your local dealer.

YOUR NOTES

ENGINE TROUBLESHOOTING

Introduction

The tables which follow indicate troubleshooting procedures based upon certain problem indicators, the probable causes of the problems, and the recommendations to overcome these problems.

Note that the engine's control system (electrical system) is protected by a 20-Ampere manual reset circuit breaker located on a bracket on the right side of the engine, just forward of the generator's end plate. The preheat solenoid is close by, as is the emergency STOP switch, which may be mounted on the same bracket or on the back of the standard instrument panel, depending upon the model.

Problem	Probable Cause	Verification/Remedy
PREHEAT switch is depressed: no panel indications, fuel solenoid, electric fuel pump and preheat solenoid not energized.	1. Battery switch not on. 2. 20-Amp circuit breaker tripped.	1. Check switch and/or battery connections. 2. Reset breaker; if breaker trips again, check preheat solenoid circuit and check circuit for shorts to ground
START switch is depressed: no starter engagement.	1. Connection to solenoid faulty. 2. Faulty START switch. 3. Faulty solenoid. 4. Loose battery connection. 5. Low batteries.	1. Check connection. 2. Check switch with ohmmeter. 3. Check that 12 volts are present at starter solenoid energizing spade terminal when switch depressed. 4. Check battery connection. 5. Check battery charge state.
START switch is depressed: panel indications OK; start solenoid OK; fuel solenoid not functioning.	1. Poor connections to fuel solenoid. 2. Defective fuel solenoid.	1. Check connections. 2. Check mechanical positioning of fuel solenoid for plunger bottoming. 3. Manually check movement of fuel solenoid plunger and throttle arm. 4. Check for voltage drop at solenoid during preheat. Check wire size from remote panels.

No ignition: cranks, but does not start; fuel solenoid energized.	1. Faulty fueling system.	1. Check for fuel to generator engine. 2. Check for air in fuel system. Bleed point on filter. 3. Fuel lift pump faulty. 4. Filters clogged. (Replace filters and allow system to self-bleed by depressing only the PREHEAT switch.
Failure to stop.	1. STOP switch failure. 2. Fuel solenoid return spring. 3. Fuel injection pump failure.	1. Stop engine by depressing emergency STOP switch on engine or manually moving the shut off lever on the injection pump side. Test switch with ohmmeter. 2. Stop engine by manually moving the throttle lever to shut off. That failing, shut off fuel and air. Check fuel solenoid linkage and repair for free movement.
Engine stops.	1. Low oil pressure or overheated. 2. Low oil pressure switch opens. 3. High temperature switch opens at too low a temperature. (water temperature) (exhaust temperature) 4. 20-Amp circuit breaker tripping.	1. Check oil level; check fresh and sea water cooling. 2. Check for satisfactory operation with switch bypassed. Check with an ohmmeter. 3. Check for satisfactory operation with switch bypassed. Check with an ohmmeter. 4. Check for high DC amperage draw during operation. Ensure switch is not overly sensitive to heat which would cause tripping.
	5. Emergency STOP switch or STOP switch in panel defective, opening fuel run solenoid circuit.	5. Check operation of switch with an ohmmeter.
	6. Switches and/or wiring.	6. Inspect all wiring for short circuits and loose connections. Inspect switches for proper operation

Battery not charging.	1. Alternator drive.	1. Check drive belt tension. Be sure alternator turns freely. Check for loose connections. Check output with voltmeter. Ensure 12 volts are present at the R terminal.
Battery runs down.	1. Oil pressure switch.	1. Observe if gauges and panel lights are activated when engine is not running. Test the oil pressure switch.
	2. High resistance leak to ground.	2. Check wiring. Insert sensitive (0-.25 Amp) meter in battery lines. (Do not start engine.) Remove connections and replace after short is located.
	3. Low resistance leak.	3. Check all wires for temperature rise to locate the fault.
	4. Alternator.	4. Disconnect alternator at output, after a good battery charging. If leakage stops, remove alternator and bench test. Repair or replace.

MAINTENANCE AND ADJUSTMENTS

Introduction

This section contains a scheduled preventive maintenance program and several adjustment procedures the owner/operator can perform without the benefit of sophisticated and expensive tools and instruments.

Preventive Maintenance

Perform the preventive maintenance in accordance with the schedules listed in the following paragraphs. Adherence to these schedules will ensure the equipment is maintained in the best possible condition and that it will perform to expectations. Those items marked by an asterisk (*) are recommended to be performed by an authorized dealer or distributor.

Daily (before each use)

1. Check the oil sump level. Maintain the oil level at or near the upper level mark on the dipstick.

2. Check the coolant level in the plastic recovery tank. Maintain this level at or above the level marked ADD. Periodically, check the coolant level in the manifold. It should be filled to the top of the filler neck.

3. Visually inspect the unit; check for loose belts, chafed or broken wires, loose brackets and fittings, damaged hoses, loose clamps and other equipment not properly secured.

4. Check the fuel supply. Fill tank(s) with a good grade of No. 2 diesel fuel, if required.

5. Check the primary filter/water separator. Drain and service as required. (A primary filter/water separator is optional, but strongly recommended as damage to fuel equipment on the engine from fuel contaminants is not warrantable.)

6. Check the generator's gauges or lights for proper oil pressure, operating temperature, and starting battery charging voltage once the engine is operating.

7. Check the generator's output meters (when installed) for proper AC voltage and output frequency.

Monthly

Check the condition of the zinc anode in the heat exchanger's sea water circuit. Clean or replace the anode, as required. Keep the area inside the heat exchanger clean of zinc anode debris.

Servicing After Initial 50 Hours of Operation

1. Change the engine's lubrication oil and oil filter.

2. Replace the fuel filter element in the engine-mounted secondary fuel filter. Change the fuel filter element and clean the filter/water sedimentor, if a separator has been installed, and if the model type permits cleaning.

*3. Retorque the cylinder head bolts.

*4. Adjust valve clearances.

5. Adjust the water pump drive belt tension, if required.

*6. Adjust the engine's no-load speed, if required (Hertz) and the regulator board's voltage output adjustment as needed. Please note that these adjustments are not a warrantable adjustment during or after the unit's break-in.

7. Check electrical connections to the fuel solenoid. Make sure the fuel solenoid operates properly when 10-12 volts are present at the solenoid during preheat.

Servicing After Every 100 Hours of Operation

1. Change the engine's lubrication oil and oil filter.

2. Adjust the alternator and water pump drive belt tension, if required.

3. Check siphon break assembly for proper operation (when installed).

Servicing After Every 250 Hours of Operation

1. Replace the spin-on fuel filter element on the engine-mounted filter assembly.

Servicing After Every 500 Hours of Operation

*1. Adjust the valve clearances.

*2. Torque the cylinder head bolts.

3. Drain, flush and refill the fresh water cooling system. There are two drain plugs for the fresh water system. One on the lower side of the heat exchanger and the other behind the hose adjacent to the engine-mounted fuel filter.

*4. Check the condition of the starter motor drive pinion; lubricate pinion.

5. Check the resistance of the glow plugs (.4 to .6 ohm). Remove the glow plugs from the engine and clean the carbon build up from the pencil end. Use anti seize compound on the threads when reinstalling.

6. Check the internal condition of the water injected exhaust elbow. Inspect the exhaust and water passages. Remove any carbon and/or corrosion build up.

7. Check the raw water pump for internal wear. Examine the pump's cover, cam, and internal housing. Replace worn parts as needed. Check for leaks at seals or gaskets and repair them, as needed.

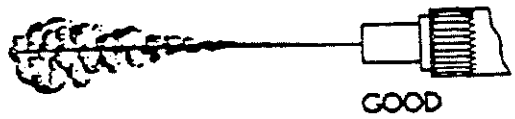
Note: Items highlighted by an asterisk (*) should be performed by a competent mechanic.

Servicing After Every 800 Hours of Operation

*1. Remove and check fuel injectors.

Injector spray pressure:
1988 psi ± 142 psi
(140 kg/cm^2 ± 10 kg/cm^2)

Eliminate undesirable injection conditions including after dripping.



*2. Check the engine's compression pressure. Remove each glow plug and check each cylinder's compression pressure. The engine's cranking speed is at 280 rpm.

Standard	Minimum	
397.6 psi (28 kg/cm^2)	312.4 psi (22 kg/cm^2)	(Maximum difference between cylinders: 35.5 psi [2.5 kg/cm^2])

*3. Check the DC Charging Circuit for proper operation.

*4. Check the tightness of bolts, nuts, and clamps.

Servicing After Every 1000 Hours of Operation

1. Remove, clean, and pressure test the primary heat exchanger. (A local automotive radiator shop should be able to clean and test the heat exchanger.)

   NOTE: Operating in silty and/or tropical waters may require that a heat exchanger cleaning be performed more often than every 1000 hours.

*2. Check the injection pump's timing. (Static method spill time.)

A. Rotate the engine's crankshaft to position the #1 piston at the Top Dead Center of its compression stroke. Observe the opening and closing of the valves for this cylinder so as not to place the piston at TDC of the exhaust stroke.

   Align the TDC mark on the crankshaft front pulley with the timing marker on the front gear case cover when positioning the #1 Piston at TDC of its compression stroke. Confirm this by rotating the crankshaft approximately 20° before and after this point and the two valves for the #1 cylinder should not move.

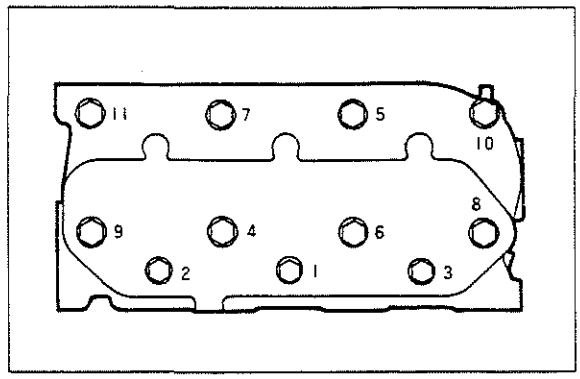
   Adjust the valve clearances for both the intake and exhaust valves for this cylinder

B. Rotate the crankshaft 240° (degrees). This puts the #3 piston at the TDC position in it's cylinder. Adjust the valve clearances for the intake and exhaust valves of the #3 piston at the TDC position in it's cylinder. Adjust the valve clearances for the intake and exhaust valves of the #3 cylinder.

C. Rotate the crankshaft another 240°. This puts the #2 piston at the TDC position in its cylinder. Adjust the valve clearances for the intake and exhaust valves of the #2 cylinder.

Torquing Cylinder Head Bolts

Tighten the cylinder head bolts according to the sequence shown in the illustration to the right. Make sure the engine is cold when this is done. Before applying the specified torque to the bolt, loosen it 1/4 to 1/2 of a turn and then apply the torque. Follow this procedure according to the numbered sequence shown in the illustration to the right.



Cylinder Head Bolt Tightening Sequence

Bolts #1,2, and 3, (12 mm socket) 2.0 ~ 3.0 kg-m (14 ~ 22 ft-lb)
Bolts #4,5,6,7,8,9,10, and 11 (14 mm socket) 7.5 ~ 8.5 kg-m (54~61 ft-lb)
(Rockershaft Hold Down Bolts - 12 mm socket - 1.5~2.2 kg-m (11~16 ft-lb)

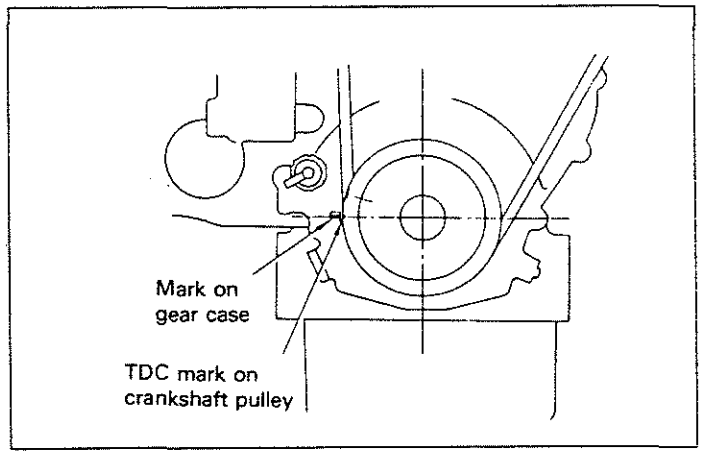
Valve Clearance Adjustment

CAUTION

Adjust the valve clearance when the engine is cold. Valves are adjusted by cylinder in the firing order of the engine.

Tighten the cylinder head bolts to the specified torque before adjusting the valves.

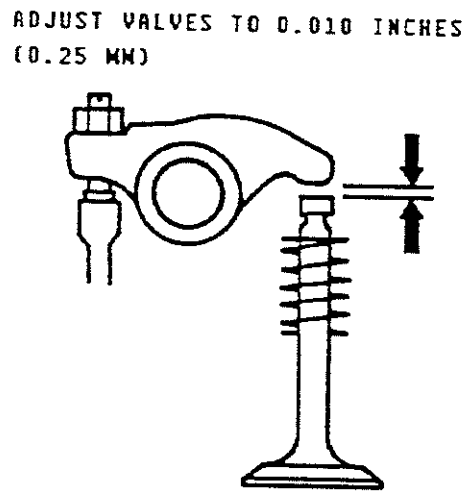
1. Pull off the air breather pipe from the rocker cover, and take off the cover bolts and the rocker cover to expose the rocker shaft and valve assembly.



Timing mark

2. Adjust the valve clearances at TDC for each cylinder when they are on their compression stroke. Remember the engine's firing order is 1 - 3 - 2. You may find that turning the engine's crankshaft is more easily accomplished when the engine's glow plugs are removed before the crankshaft is rotated.

Adjust each valve's clearance by inserting a 0.010 inch (0.25 mm) feeler gauge between the rocker arm and the valve stem.

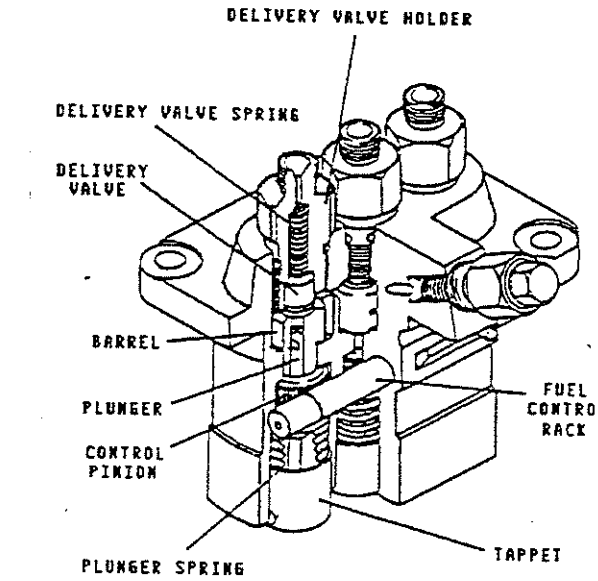


Injection Pump Timing Adjustment (Spill Timing)

If your engine's fuel injection timing is not properly adjusted, the engine will not operate properly and may be difficult to start. Have the injection pump delivery rate checked by a well-established fuel injection shop. Adjust the injection timing as follows:

> NOTE: The fuel shut-off lever must be in the RUN position while making the adjustment or no fuel will flow from the fuel injection pump.

Refer to the illustration below when servicing the fuel injection pump. First remove the high-pressure fuel line from between the No. 1 injector and the No. 1 fuel delivery valve holder. Remove the No. 1 fuel delivery valve holder and remove the delivery valve spring beneath the holder. Reinstall only the delivery valve holder and reattach the high pressure fuel line to the delivery holder. Attach it so that the end that would connect to the fuel injector is pointing away from the engine. Fuel will flow from this line during the timing check.



Rotate the engine's crankshaft in its normal direction of rotation to position piston No. 1 at the beginning of its compression stroke.

Move the throttle lever to its full open position and operate the electric lift pump. Slowly rotate the crankshaft clockwise (as viewed from the front), catching the fuel from the No. 1 fuel line, until the instant the fuel completely stops flowing (no drips). At this instant, the 16° BTDC timing mark on the crankshaft pulley should be directly aligned with the timing indicator on the front of the gear case ± .5 degrees.

If the specified injection timing (16° BTDC) cannot be attained, adjust the timing by increasing or decreasing the thickness of shim material under the injection pump's mounting flange to change the injection timing point. Changing the shim thickness by 0.004 inch (0.01 mm) changes the injection by approximately one degree. To advance the timing, decrease the shim thickness, as required. To retard the timing, increase the shim thickness, as required. Refer to your generator's Parts List for shim part numbers.

Adjustments (Generator)

Once the diesel generator set has been placed in operation, there may be adjustments required for engine speed (hertz) during the engine's break-in period (first 50 hours) or after this period. A no-load voltage adjustment may also be required in conjunction with the engine's speed adjustment. These are not warrantable adjustments as they relate to normal break-in and maintenance.

CAUTION

When starting the generator, all AC loads, especially large motors, should be switched off until the engine has come up to speed and, in cold climates, starts to warm up. This precaution will prevent damage caused by unanticipated operation of AC machinery and will prevent a cold engine from stalling.

Generator Frequency Adjustment (Hertz)

Frequency is a direct result of engine/generator speed, as indicated by the following:

When the generator is run at 1800 rpm, the AC voltage output frequency is 60 Hertz.
When the generator is run at 1500 rpm, the AC voltage output frequency is 50 Hertz.

Therefore, to change the generator's frequency, the engine speed must be changed. To accomplish the frequency change, perform the following:

1. Connect the AC output leads to the AC terminal block in accordance with the AC voltage connections diagram specified for your generator set, and change the hertz connection to the capacitor. These connections are illustrated in the "BC GENERATOR" section of this manual.

2. Adjust the engine's speed to obtain the frequency corresponding to the voltage selected by adjusting the stop bolts and positioning the throttle arm against these stop bolts to either increase or decrease engine no-load speed to adjust hertz produced.

To arrive at the appropriate frequency, either monitor the speed of the engine/generator with a tachometer, or monitor the frequency with a frequency meter, the latter method being the more precise of the two.

Fuel Shut-off Solenoid - Installation Instructions

The fuel shut-off solenoid #037100 is mounted in a threaded boss on the engine's block just aft of and below the engine's fuel injection pump. Proceed as follows when installing a replacement or new fuel shut-off solenoid.

1. Visual access to the fuel injection pump's fuel rack is needed. To obtain this, remove the small square side cover/bracketry just below the fuel injection pump. This is shown as cover part #037045 and gasket #036981 in the parts list.

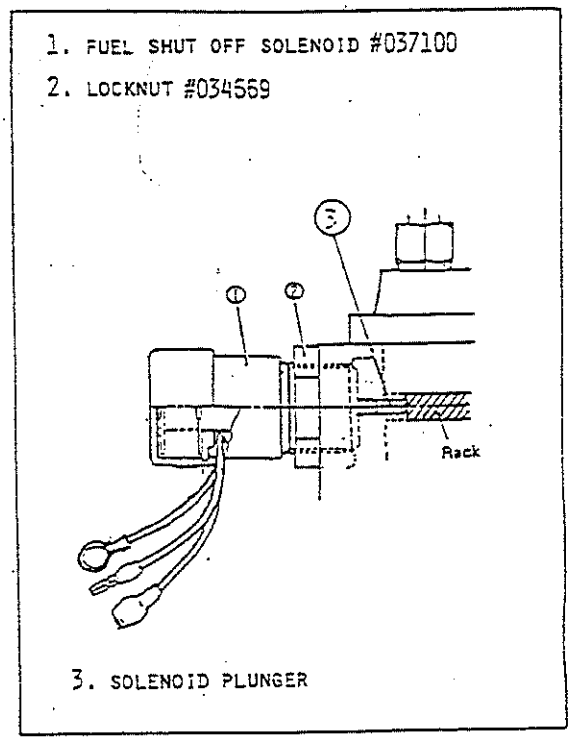
2. Thread the locknut #034669 onto the solenoid and then apply a small amount of Teflon sealant to the threads on the solenoid.

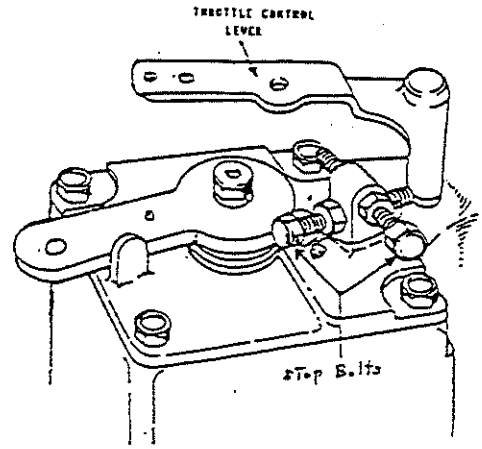
3. Thread the solenoid into the boss on the engine and observe the solenoid plunger through the cover opening. Allow the plunger to contact the fuel rack and move it fully into the injection pump. Do not thread further so as to push the plunger into the solenoid.

4. Back the solenoid out 1/4 - 1/2 of a turn and secure it in position with the locknut.

5. Properly connect the three electrical leads from the solenoid. Two of the connections plug into the engine harness and the third grounds to the engine block at an adjacent inboard threaded boss with an 8mm bolt.

6. Reassemble the cover/bracketry and test run the unit. Ensure that the unit stops when the solenoid is de-energized.





LAY-UP AND RECOMMISSIONING

General

Many owners rely on their boatyards to prepare their craft, including engines and generators, for lay-up during the off-season or for long periods of inactivity. Others prefer to accomplish lay-up preparation themselves.

The procedures which follow will allow you to perform your own lay-up and recommissioning, or to use as a check list if others do the procedures.

These procedures should afford your engine protection during a lay-up and also help familiarize you with the maintenance needs of your engine.

If you have any questions regarding lay-up procedures, call your local servicing dealer; he will be more than willing to provide assistance.

Fresh Water Cooling System

A 50-50 solution of antifreeze and fresh water is recommended for use in the fresh water cooling system at all times. This solution may require a higher concentration of antifreeze, depending on the area's winter climate. Check the solution to make sure the antifreeze protection is adequate.

Should more antifreeze be needed, drain an appropriate amount from the engine block and add a more concentrated mixture. Operate the engine to ensure a complete circulation and mixture of the antifreeze concentration throughout the cooling system. Now recheck the antifreeze solution's strength.

Lubrication System

With the engine warm, drain all the lubricating oil from the oil sump. Remove and replace the oil filter. (Place some paper towels and a plastic bag around the filter to catch the oil during its removal.)

When installing the new oil filter, be sure to apply a small amount of oil on the rubber sealing gasket at the base of the filter. Fill the sump with the correct amount of oil for your engine. (Refer to the "SYSTEM SPECIFICATIONS" section of this manual.) Use an oil with an API specification of CC or CD. Run the generator and check for proper oil pressure and make sure there are no leaks.

CAUTION

Do not leave the engine's old lubricating oil in the sump over the lay-up period. Lubricating oil and combustion deposits combine to produce harmful chemicals which can reduce the life of your engine's internal parts.

Fuel System

Top off your fuel tanks with No. 2 diesel fuel. Fuel additives should be added at this time to control algae and condition the fuel. Care should be taken that the additives used are compatible with the primary filter/water separator used in the system. Change the element in your primary fuel filter/water separator, if the fuel system contains one, and clean the separator sediment bowl.

Change the fuel filter element on the engine and bleed the fuel system, as needed. Start the engine and allow it to run for 5 - 10 minutes to make sure no air is left in the fuel system. Check for any leaks that may have been created in the fuel system during this servicing, correcting them as needed.

Sea Water Circuit

Close the through-hull sea cock. Remove the raw water intake hose from the sea cock. Place the end of this hose into a 5-gallon bucket of clean fresh water. Before starting the engine, check the zinc anode found in the primary heat exchanger on the engine and clean or replace it as required, and also clean any zinc debris from inside the heat exchanger where the zinc anode is located. Clean the raw water strainer, if one is installed, in the inside of the hull.

Start the engine and allow the raw water pump to draw fresh water through the system. When the bucket is empty, stop the engine and refill the bucket with an antifreeze solution slightly stronger than needed for winter freeze protection in your area.

Start the engine and allow all of this mixture to be drawn through the raw water system. Once the bucket is empty, stop the engine. This antifreeze mixture should protect the raw water circuit from freezing during the winter lay-up, as well as providing corrosion protection.

Remove the impeller from your raw water pump (some antifreeze mixture will accompany it, so catch it in a bucket). Examine the impeller. Acquire a replacement, if needed, and a cover gasket. Do not replace the impeller (into the pump) until recommissioning, but replace the cover and gasket.

Intake Manifold and Through-Hull Exhaust

Place a clean cloth, lightly soaked in lubricating oil, in the opening of the intake manifold to block the opening. Do not shove the cloth out of sight. (If it is not visible at recommissioning, and an attempt is made to start the engine, you may need the assistance of a servicing dealer.) Make a note to remove the cloth prior to start-up. The through-hull exhaust port can be blocked in the same manner.

Generator End

Remove the louvered cover on the generator end. Check all wire connections on the AC terminal block and those running to the capacitor(s) and the bridge rectifier making sure they are secure. Should these connections appear corroded, they should be removed, cleaned, and reconnected. Make sure all AC leads are properly cleaned and reconnected. Make sure all AC leads are properly supported and not chafing as they exit the generator housing.

Starter Motor

Lubrication and cleaning of the starter drive pinion is advisable, if access to the starter permits its easy removal. Make sure the battery connections are shut off before attempting to remove the starter. Take care in properly replacing any electrical connections removed from the starter.

Cylinder Lubrication

It is not necessary to remove the fuel injectors from the cylinder head to squirt light lubricating oil into the cylinders for the few months of normal lay-up. However, if you anticipate a longer lay-up period (12 months or more), we recommended that this procedure be performed. The light oil in the cylinders will prevent the piston rings from sticking to the cylinder walls. Make sure you have replacements for the injector and return line sealing washers.

Spares

Lay-up time provides a good opportunity to inspect your Westerbeke engine to see if external items such as drive belts or coolant hoses need replacement. Check your basic spares kit and order items not on hand, or replace those items used during the lay-up, such as filters and zinc anodes. Refer to the "SPARE PARTS" section of this manual.

Batteries

If batteries are to be left on board during the lay-up period, make sure they are fully charged, and will remain that way, to prevent them from freezing. If there exists any doubt that the batteries will not remain fully charged, or that they will be subjected to severe environmental conditions, remove the batteries and store them in a warmer, more compatible environment.

Recommissioning

The recommissioning of your Westerbeke engine after a seasonal lay-up generally follows the same procedures as those presented in the "PREPARATIONS FOR STARTING" section regarding preparation for starting and normal starts. However, some of the lay-up procedures will need to be counteracted before starting the engine.

1. Remove the oil-soaked cloths from the intake manifold and from the through-hull exhaust port.

2. Remove the raw water pump cover and gasket and discard the old gasket. Install the raw water pump impeller removed during lay-up (or replacement, if required). Install the raw water pump cover with a new cover gasket.

WARNING

Wear rubber gloves, a rubber apron, and eye protection when servicing batteries. Lead acid batteries emit hydrogen, a highly-explosive gas, which can be ignited by electrical arcing or a lighted cigarette, cigar, or pipe. Do not smoke or allow an open flame near the battery being serviced. Shut off all electrical equipment in the vicinity to prevent electrical arcing during servicing.

3. Reinstall the batteries that were removed during the lay-up, and reconnect the battery cables, making sure the terminals are clean and that the connections are tight. Check to make sure that the batteries are fully-charged.

4. Check the condition of the zinc anode in the raw water circuit and clean or replace the anode as needed. Note that it is not necessary to flush the antifreeze/fresh water solution from the raw water coolant system. When the engine is put into operation, the system will self-flush in a short period of time with no adverse effects. It is advisable to, as either an end of season or recommissioning service to inspect the area that the zinc is located at in the heat exchanger and clear any and all zinc debris from that area.

5. Start the engine in accordance with procedures in the "PREPARATIONS FOR STARTING"section of this manual.

REMOTE LUBE OIL FILTER KIT - PN#040078

This kit allows you to remove the filter off the engine and with the mounting bracket contained in the kit, mount the filter on an adjacent bulkhead for clean, easy servicing. Contact your local dealer for information on purchasing this kit.

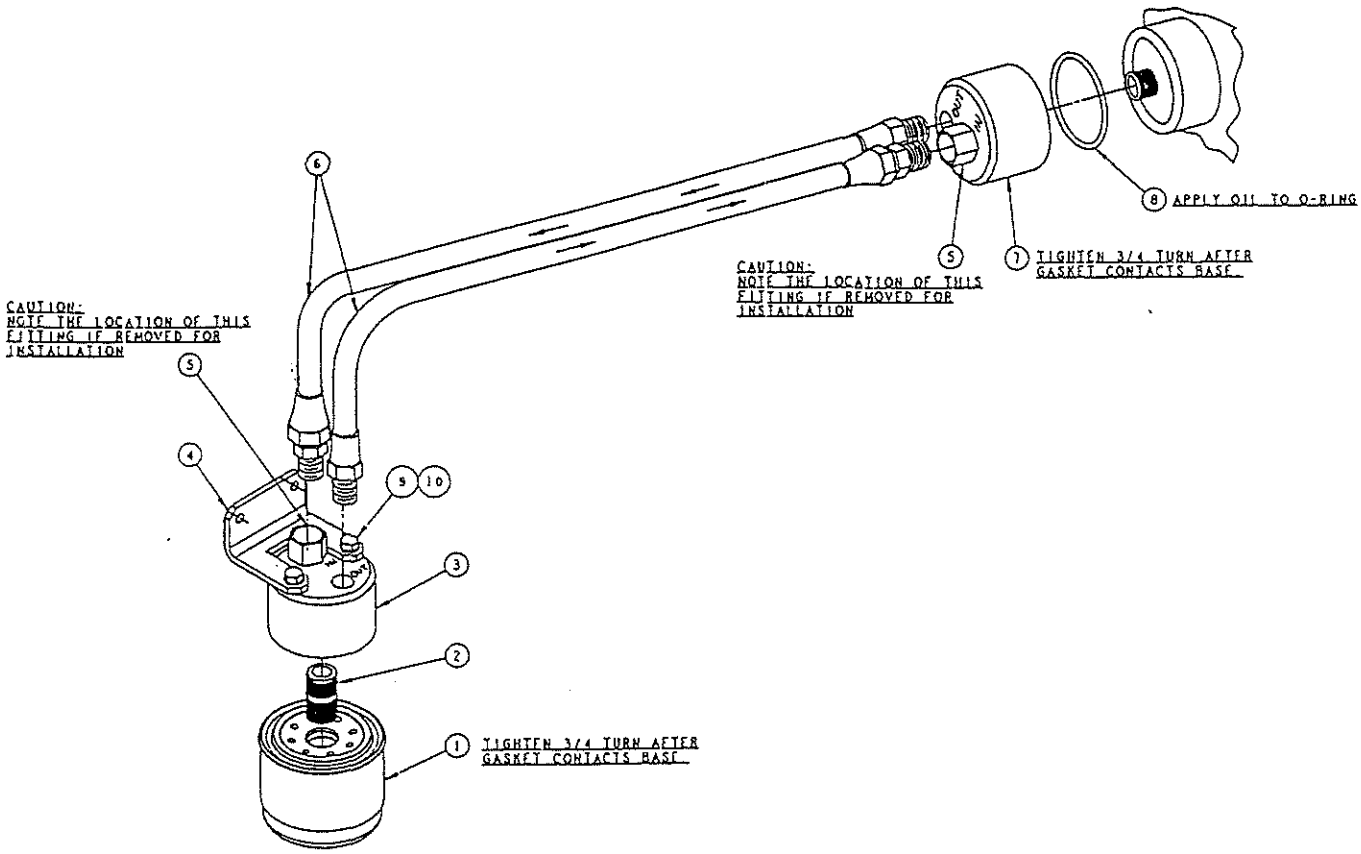

CAUTION:
NOTE THE LOCATION OF THIS FITTING IF REMOVED FOR INSTALLATION
CAUTION:
NOTE THE LOCATION OF THIS FITTING IF REMOVED FOR INSTALLATION
8 APPLY OIL TO O-RING
7 TIGHTEN 3/4 TURN AFTER GASKET CONTACTS BASE
1 TIGHTEN 3/4 TURN AFTER GASKET CONTACTS BASE

TABLE OF STANDARD HARDWARE TIGHTENING TORQUES

Unless stated otherwise for a specific assembly, use the following torque values when tightening standard hardware.

	Pitch	lb-ft	kg-m
Grade 4			
6mm bolt head/nut	1	2.9 - 5.1	0.4 - .07
8mm bolt head/nut	1.25	7.2 - 11.61.0 - 1.6	
10 mm bolt head/nut	1.25	13.7 - 22.4	1.9 - 3.1
10 mm bolt head/nut	1.5	13.0 - 21.7	1.8 - 3.0
12 mm bolt head/nut	1.25 (ISO)	25.3 - 39.8	3.5 - 5.5
12 mm bolt head/nut	1.5	25.3 - 39.8	3.5 - 5.5
12 mm bolt head/nut	1.75	21.7 - 36.2	3.0 - 5.0
13 mm bolt head/nut	1.5	32.5 - 50.6	4.5 - 7.0
14 mm bolt head/nut	1.5	36.2 - 57.9	5.0 - 8.0
14 mm bolt head/nut	2	34.0 - 55.7	4.7 - 7.7
16 mm bolt head/nut	1.5	54.2 - 79.6	7.5 - 11.0
16 mm bolt head/nut	2	51.4 - 76.7	7.1 - 10.6
Grade 6T			
6mm bolt head/nut	1	4.3 - 6.5	0.6 - 0.9
8mm bolt head/nut	1.25	10.8 - 15.9	1.5 - 2.2
10 mm bolt head/nut	1.25	21.7 - 32.5	3.0 - 4.5
10 mm bolt head/nut	1.5	19.5 - 30.4	2.7 - 4.2
12 mm bolt head/nut	1.25 (ISO)	36.2 - 57.9	5.0 - 8.0
12 mm bolt head/nut	1.5	36.2 - 50.6	5.0 - 7.0
12 mm bolt head/nut	1.75	34.7 - 49.2	4.8 - 6.8
Grade 7T, 8T and 8.8			
6mm bolt head/nut	1	5.8 - 8.7	0.8 - 1.2
8mm bolt head/nut	1.25	14.5 - 21.7	2.0 - 3.0
10 mm bolt head/nut	1.25	28.9 - 39.8	4.0 - 5.5
10 mm bolt head/nut	1.5	26.8 - 37.6	3.7 - 5.2
12 mm bolt head/nut	1.25 (ISO)	54.2 - 75.9	7.5 - 10.5
12 mm bolt head/nut	1.5	50.6 -65.1	7.0 - 9.0
12 mm bolt head/nut	1.75	43.4 -61.5	6.0 - 8.5
13 mm bolt head/nut	1.5	57.9 - 86.8	8.0 - 12.0
14 mm bolt head/nut	1.5	72. 3 - 108.5	10.0 - 15.0
14 mm bolt head/nut	2	68.7 - 101.3	9.5 - 14.0
16 mm bolt head/nut	1.5	108.5 - 166.4	15.0 - 23.0
16 mm bolt head/nut	2	101.3 - 159.1	14.0 - 22.0
Grade 5 cap screw			
1/4 UNC		9 - 11	1.2 - 1.5
1/4 UNF		11 - 13	1.5 - 1.8
5/16 UNC		18 - 20	2.5 - 2.8
5/16 UNF		21 - 23	2.9 - 3.2
3/8 UNC		28 - 33	3.7 - 4.6
3/8 UNF		30 - 35	4.1 - 4.8
7/16 UNC		44 - 49	6.1 - 6.8
7/16 UNF		50 - 55	6.9 - 7.6
1/2 UNC		68 - 73	9.4 - 10.1
1/2 UNF		73 - 80	10.1 - 11.1

	Socket Size	Lb - ft	Kg - m
Cylinder head bolt	M 10 (14 mm)	54 - 61	7.5 - 8.5
	M 8 (12 mm)	14 - 22	2.0 - 3.0
Rocker shaft hold down bolts	M 8 (12 mm)	11 - 16	1.5 ~ 2.2

(See the "Torquing Cylinder Head Bolts" section of this manual.)

Crankshaft pulley nut	M 16 (24 mm)	72.3 - 86.7	10 -12
Connecting rod cap-nut	M 8 (14 mm)	23 - 25	3.2 - 3.5
Oil pan drain plug (All models)	M18	36.2 - 43.4	5.0 - 6.0
Oil filter (All models)		8.0 - 9.4 (or tighten firmly by hand)	1.1 - 1.3
Delivery valve holder (Injection pump)(All models)	M 16 (17 mm)	25.3 - 28.2	3.5 - 3.9
Injector nozzle mounting (All models)(To Engine)	M 20 (21 mm)	36.2 - 43.4	5.0 - 6.0
Fuel solenoid locknut	M 30 (36 mm)	28.9 - 36.2	4.0 - 5.0
Glow plug (All models)	M 10 (12 mm)	10.8 - 14.5	1.5 - 2.0
Injector spray pressure		140 ± 10/0 kg/cm^2 (1990 psi ± 140/0)	
Cylinder compression pressure		28 kg/m^2 at 280 rpm (398 psi)	

Tightening Torque for Common Bolts and Nuts

Designation of screw	Head Mark		
thread	4	7	10
M6	0.3 ~ 0.5	0.8 ~ 1.0	1.0 ~ 1.3
M8	1.0 ~ 1.3	1.5 ~ 2.2	2.5 ~3.5
M10	1.8 ~ 2.5	3.0 ~ 4.2	5.0 ~7.0
M12	3.0 ~4.2	5.5 ~ 7.5	9.5 ~ 12.0
M14	5.0 ~7.0	8.0 ~ 11.0	16.0 ~ 19.0

NOTE: Convert kg-m to ft-lb by multiplying by 7.233

SPARE PARTS

Since a possibility exists in which the engine may need to be serviced at sea or while in a port other than your home port, certain spare parts should be kept on board to help minimize delays in your voyage. Please refer to your engine's Parts List for part numbers when ordering spare parts. Listed below are those spare parts that should be carried on board at all times.

1. An impeller kit.
2. A fuel system hardware kit.
3. A secondary fuel filter element.
4. A water pump belt.
5. Hose clamps.
6. A spare oil filter with a spare quart of diesel service engine oil along with a gallon of premixed antifreeze.
7. A few zinc anodes and heat exchanger end plate gaskets.
8. An oil pressure switch.

Other parts (listed below), whose life expectancy cannot be accurately predetermined, should be carried on board (in addition to those listed above) especially if the vessel is to be taken on long ocean voyages.

1. Fuel injectors.
2. Glow plugs.
3. Cooling system hoses.
4. A starter.
5. A 20 amp DC circuit breaker.
6. An electric fuel pump.
7. A sea water pump.
8. Battery terminal connectors.
9. A fuel run solenoid.

The spare parts listed directly above are those we *recommend* be carried on board during long ocean voyages. You may wish to ask other boat owners who have similar crafts and who have completed long ocean voyages as to what spare parts they carried on board and what parts were needed at specific times on the voyage. From the list provided directly above and from these inquiries, you can determine what spare parts may be needed. In addition, if you are planning a long ocean voyage, consult your Westerbeke dealer for a listing of the Westerbeke dealers located on your route.

NOTES

SOUND GUARD INSTALLATION INSTRUCTIONS

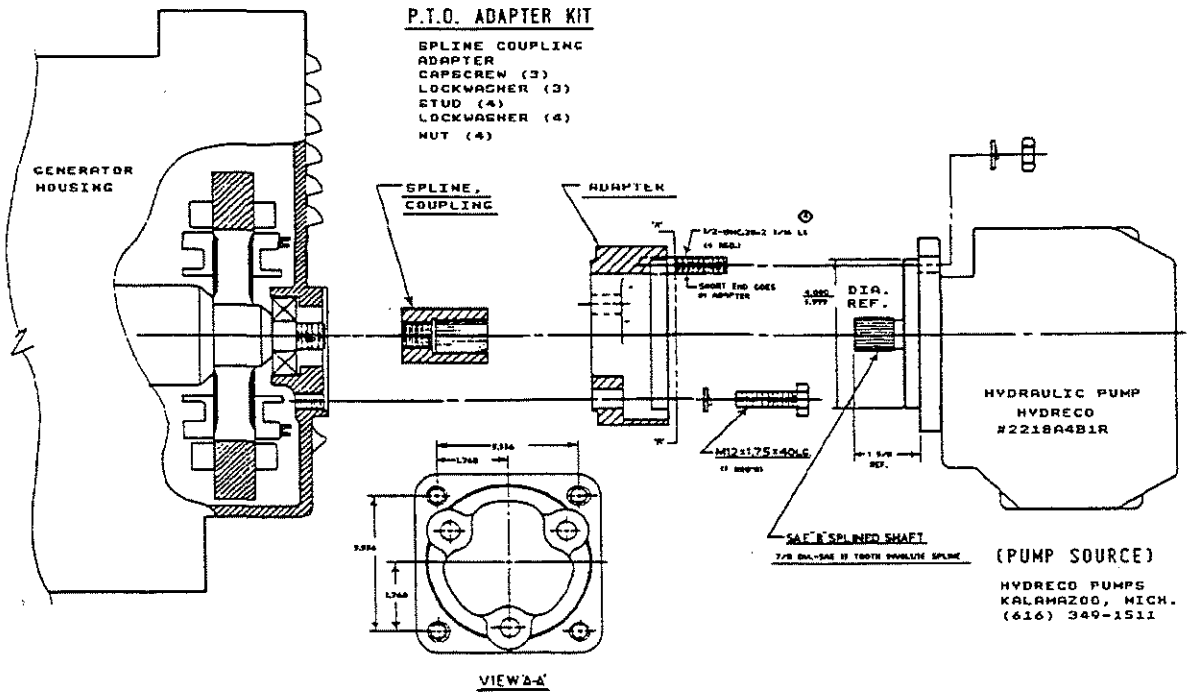
For a copy of the Sound Guard installation instructions required for your generator set, please contact your local Westerbeke dealer. A four page installation brochure is available which covers all current Sound Guard model assembly/installations.

BTD 7.6 KW POWER TAKE-OFF (PTO) ADAPTER

The generator housing of the BTD 7.6 KW is machined to accept the optional power take-off (PTO) adapter kit #34786. This kit allows the user to mount and to operate a hydraulic pump (or similar device) while the generator is operating.

The operator is advised that the generator's drive engine produces a specific horsepower at 1800 rpm (continuous), 60 Hertz (8 HP at 1500, 50 Hertz). This horsepower can be utilized either for generator AC output or to operate the PTO device. It cannot do both; that is, it cannot produce 7.6 KW of AC electrical power and furnish horsepower to the PTO device, simultaneously.

When mounting a PTO device using the optional adapter kit #34786, ensure good alignment of the device to the spline coupling and ensure that if additional support is needed, it is added. When in doubt, provide extra support.



NOTE: Provisions should be made to prevent the PTO device from overloading the generator's engine. Install a pressure relief valve on the hydraulic pump to limit maximum pumping pressure.